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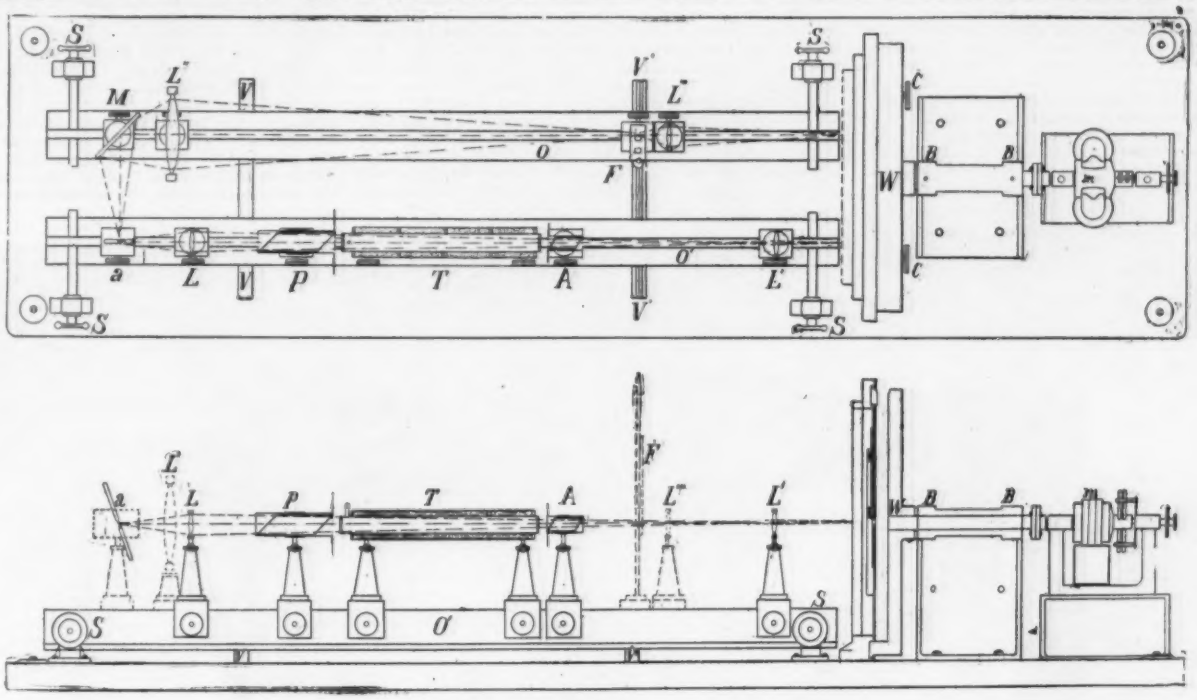

FIG. 1.

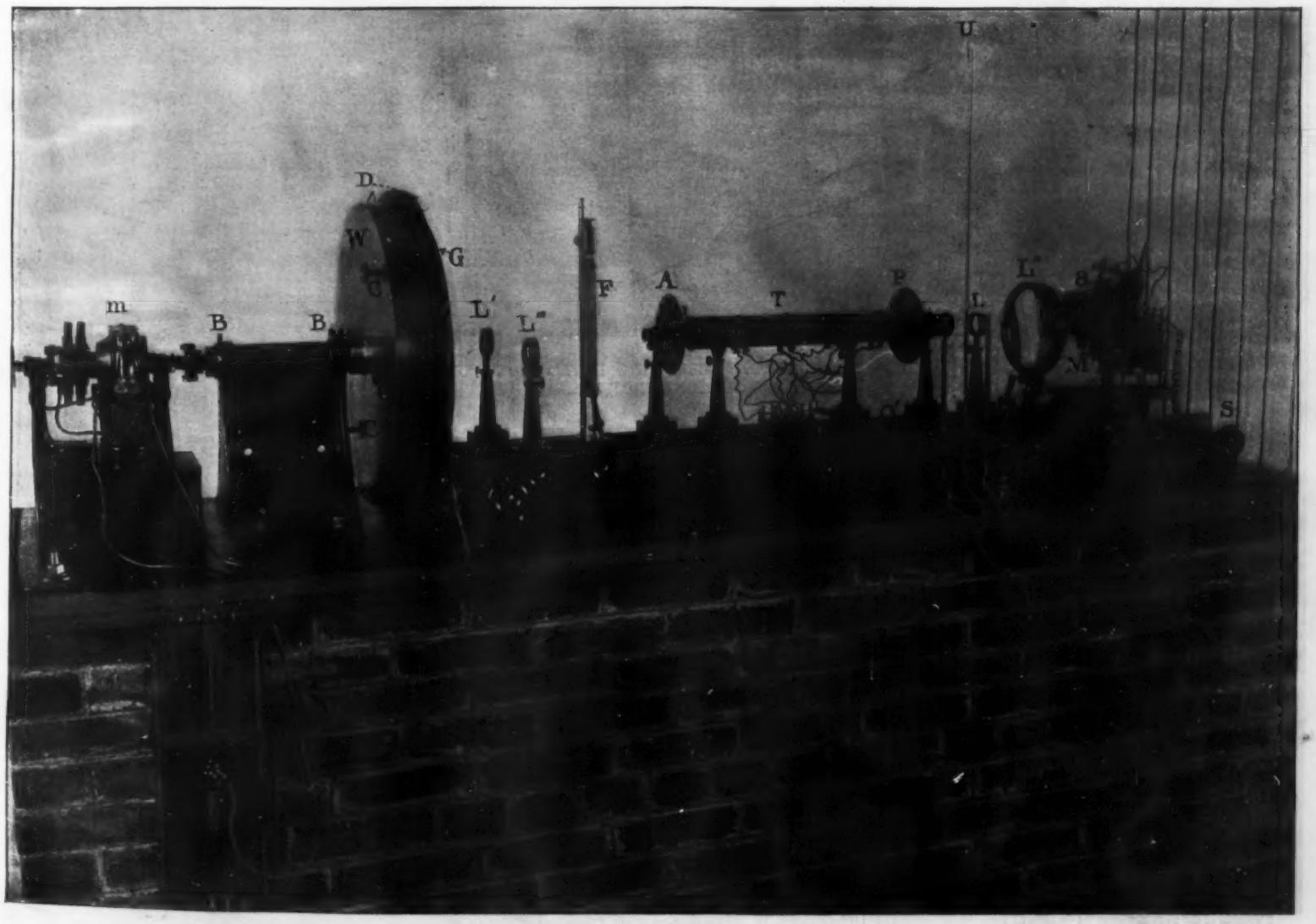

FIG. 2.—THE POLARIZING PHOTO-CHRONOGRAPH, UNITED STATES ARTILLERY SCHOOL, FORT MONROE, VA.

THE NEW POLARIZING PHOTO-CHRONOGRAPH AT THE UNITED STATES ARTILLERY SCHOOL, FORT MONROE, VA.*

IT was stated at the close of a previous paper † that the polarizing photo-chronograph authorized by the Board of Ordnance and Fortification, U. S. A., for the U. S. Artillery School, was then nearly completed.

The object of this paper is to describe this instrument and its installation, together with some of the further tests and experiments with it which were carried out in the electrical laboratory of the school where the new instrument was installed during the months of July and August, 1896. It is a pleasure to record at the outset our obligations to Mr. J. A. Brashear, of Allegheny, Pa., who constructed the chronograph, and to Messrs. Warner & Swasey, of Cleveland, Ohio, who constructed the measuring instrument for the same.

The well known reputation of each of these firms in their particular lines of work has more than been sustained, and their skill in execution as well as their experience in methods has contributed no small share in making the instrument what it is at present.

In arriving at the general form which the new instrument has assumed, naturally many radical departures from the form with which the first experiments were conducted were considered; and constructions of the camera which would permit of greater possible length of record, such as wrapping a sensitive film upon a cylinder or by causing the record to assume a spiral form upon a plane sensitive plate, which would suggest themselves almost immediately, were discarded as introducing complications of construction unnecessary for the particular object for which this form of instrument was intended, and the advantages of the general form of a movable plane glass sensitive plate appear more and more apparent with increase of experience.

Since the primary object of this apparatus is the accurate measurement of very minute intervals of time, its particular sphere of merit is in the quantitative investigation of natural phenomena beyond the reach of other methods of measurement, and where the whole period within which measurements are sought is itself a small interval of time when compared with a second, for instance.

For this reason, great length of available record, which means roughly comparatively long intervals of time, is unnecessary for the very rapid phenomena which are usually met with in scientific gunnery.

DESCRIPTION OF CHRONOGRAPH.

The essential features of the chronograph as explained in the first paper, ‡ to which reference is made, are the transmitter and the receiver. The former consists naturally of a series of lenses and prisms in the same line with the arc light and tube, so that it makes the apparatus long as compared with the width. In fact, it is made like an optical bench, a very convenient form being the inverted T-rail shown at O and O', Figs. 1 and 3. Fig. 1 shows the general arrangement of the parts of the apparatus in plan and elevation. Fig. 2 is a view of the instrument in which the lettering corresponds to that of Fig. 1. Upon the rail, O', are first the arc lamp, a, one of J. B. Colt's lamps, and in front of it the condensing lens, L. The polarizer, P, is between the lens, L, and tube, T, and immediately after the tube is the analyzer, A, and lens, L'. The receiver has the form of a sensitized glass plate revolving in its plate holder, which is itself mounted in a heavy cast iron fly wheel, W. Both receiver and transmitter are assembled upon the same cast iron base plate, which is 7 feet 3½ inches long by 2 feet wide. The second T-rail, seen at O, carries the accessories for the tuning fork which makes its record upon the sensitive plate on the opposite side to that where the chronograph record appears. Inasmuch as uniform velocity is always used in taking records, it can make no difference where the tuning fork record is placed. This rail, O, carries first a mirror, M, which reflects the light from the arc and turns it in a line parallel with the rail. It then passes through a large condensing lens, L'', and an image of the arc is formed upon a small piece of aluminum foil attached to one prong of the tuning fork, F. This foil has a small round hole in it about one mm. in diameter which is brightly illuminated by the light. The lens, L'', forms a magnified image of this luminous hole upon the moving photographic plate. Both of the T-rails travel upon two rails, VV', one of which, V, has a flat top and the other, V', a V-shaped top, which travels in two V-grooves cut one in each T-rail. The traversing motion is effected by the hand screws, SSSS, so that each rail may be moved independently of the other. The track, V', with grooves in the rails keeps the whole apparatus always at the same distance from the sensitive plate. The transverse motion of the rails is for the purpose of making either the chronograph or tuning fork records adjustable, so that they may be set at any desired distance from the axis of rotation of the plate. This makes it possible to take several records upon the same plate, a circumstance of great practical convenience.

The camera fly wheel, W, is mounted upon the end of a shaft 1¼ inches in diameter carried by the ball bearings at BB.

The armature of a ½ horse power electric motor, m, manufactured by the Crocker-Wheeler Co., is directly coupled to the camera shaft. The motor is not specially constructed, but is one of their standard commercial types. The wheel is so nicely balanced that it will rest in any position where it is left, but the slightest touch of the hand is sufficient to turn it. The motor is wound for low voltage, about twelve volts being the highest ever needed. The inertia of the wheel is so great that it takes several minutes to attain full speed, and it will run many minutes after the power is cut off before coming to rest.

The plate holder is made of metal to accommodate two plates 12 × 12 inches square. The holder is held in position by four thumb screws, CCCC, Fig. 2, to prevent the possibility of its flying out when rapidly rotating.

The front part of the camera is a casting bolted to the base plate, and in the form of a ring with a section of such a shape that it surrounds the rotating wheel so as to prevent any light from reaching the sensitive plate when the slide is drawn from the plate holder. The wheel, W, has a flange upon the circumference of it, the section of which just fits the stationary ring, making a small clearance, and after the solid cast ring is bolted down, a light brass ring is screwed on so as to serve as additional security against outside light. This arrangement has proved to be entirely effectual in preventing fogging of the plates.

The light for the chronograph record is made to pass through a narrow radial slit, and to produce as sharp and definite records as possible, it is desirable to have the slit close to the sensitive plate itself. To support the slit in this position a thin brass plate is screwed to the back of the ring, covering the whole of it, and thus forming a complete screen preventing any light entering from in front. The radial slit has upper jaw fixed and edge coinciding with a radius of the wheel. The lower jaw is pivoted at the center and may be clamped in any position by a thumb screw. This arrangement always insures a radial slit capable of adjustment for any width.

Since the camera slide shutter must fall immediately in front of this slit in the brass partition to shut off all light before and after exposure, it makes it necessary to have no projecting parts on the front of the brass plate which would interfere with the shutter in its fall.

The light from the tuning fork reaches the plate through a round opening. This hole is made in a small slide movable diagonally along a slot. The slot is made in a second slide movable vertically along guides. This arrangement permits the adjustment of the hole along a radius of the wheel, and neither interferes with the jaw pivoted at the center, nor has any projections which the camera slide might strike in falling. Across the hole in the slide are secured several fine vertical wires, the shadows of which form the centering circles upon the plate, as previously explained.

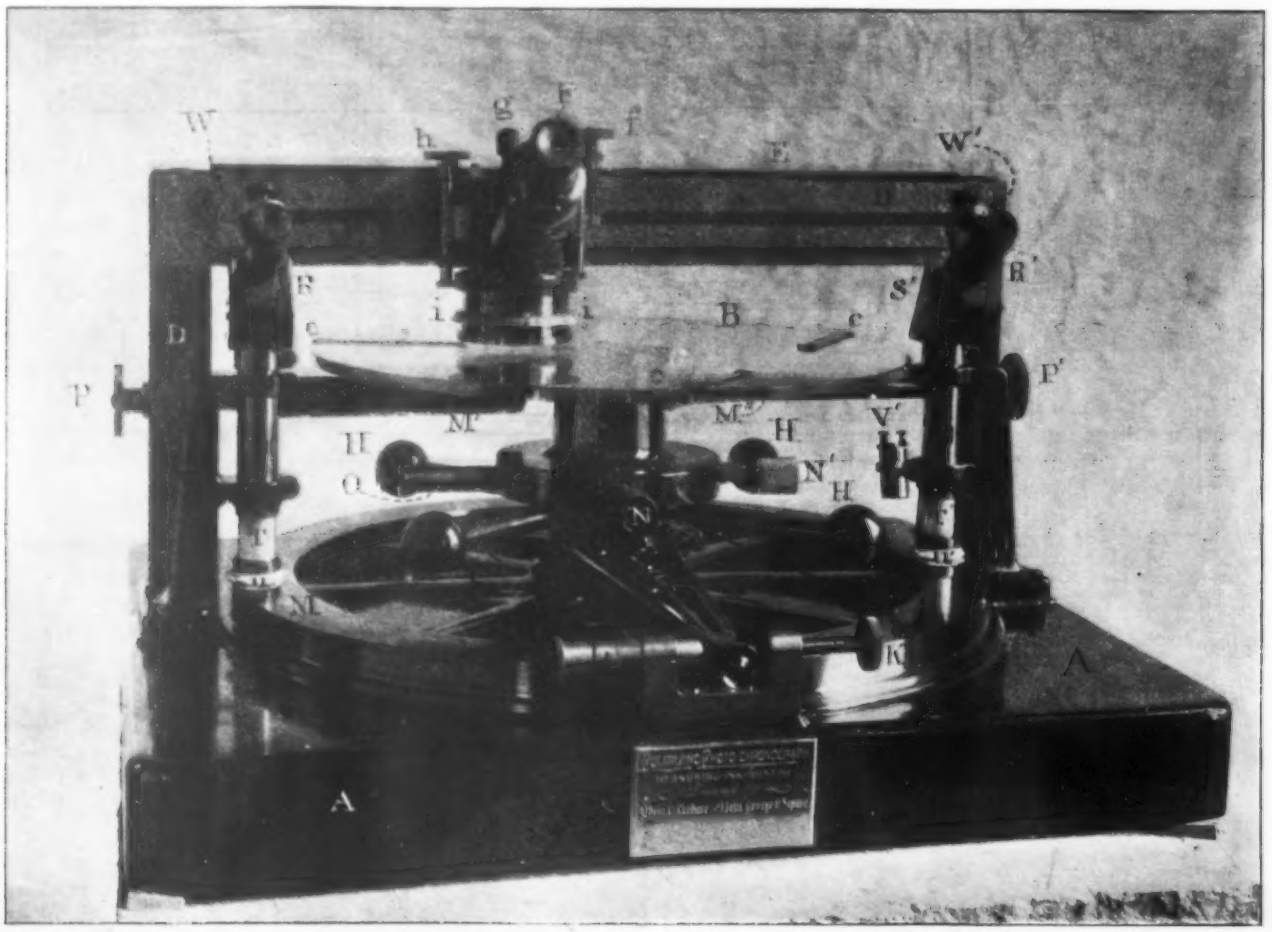

FIG. 3.—THE POLARIZING PHOTO-CHRONOGRAPH MEASURING INSTRUMENT, UNITED STATES ARTILLERY SCHOOL, FORT MONROE, VA.

THE CAMERA SLIDE SHUTTER.

In order to control the time of exposure of the slit so that the sensitive plate may not revolve more than once while the slit is open, a camera gravity slide shutter is provided. It consists of a frame of thin sheet metal forming a curtain with an adjustable rectangular opening.

When this shutter is raised, the lower part normally covers both the radial slit and the opening for the tuning fork record, and is held suspended by an automatic catch upon the armature of a small electro-magnet, which is permanently attached to the inside of the ring, with its binding posts on the outside. To operate the shutter at any distance from the camera, it is only necessary to close an electric circuit passing to the binding posts referred to. Since this shutter has considerable weight, its lower circular edge is provided with a thick rubber cushion extending along the entire lower edge, which serves to soften the shock of the fall. In order to prevent the possibility of the shutter rebounding sufficiently to expose the slit a second time, an automatic bevel catch lock is attached to the inside of the ring at its lowest point. In rising and falling the shutter rides between vertical guides upon the four beveled rollers.

The operation of this shutter in opening and closing the radial slit is as follows:

The shutter being up, its lower part closes the slit, and upon being released, when it falls a certain fixed distance, the edge first exposes the slit, and it remains exposed until the upper edge closes it in the fall. The

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* By Dr. Albert Cushing Crehore, Assistant Professor of Physics, Dartmouth College, and Dr. George Owen Squier, First Lieutenant, Third Artillery, U. S. A., Instructor Department of Electricity and Mines, United States Artillery School.

† Experimental determination of the motion of projectiles inside the bore of a gun with the Polarizing Photo Chronograph.—Journal of the U. S. Artillery, May-June, 1896.

‡ Journal of the U. S. Artillery, vol iv., No. 3.

total time of exposure may by this means be set for any time ranging from zero to a certain maximum, about a tenth of a second.

To cover the entire front of the camera ring, a wooden circular face is provided, which can be removed at pleasure, and two small windows upon either side sliding longitudinally in grooves permit the light for the chronograph and tuning fork records to enter. This cover is simply an additional precaution and to provide a means of exposing the slit by hand independent of the camera shutter when desired. This cover in position forms an additional small dark chamber in the space between the camera shutter and the front face of the stationary camera ring. In the ordinary use of the camera slide shutter for exposing the plate, this wooden cover may be dispensed with.

THE GRAVITY SWITCH.

The gravity switch and its function in exposing the camera and firing the gun has been explained in the first paper. The form for the new instrument is substantially the same as the rough one made for the first experiments. It is shown at U, Fig. 2, and for convenience in setting and dropping the firing weight, the central rod along which the square brass cylinder falls is permanently graduated in inches, as also are the side rods which bear the pairs of binding posts for the electric primer and the camera release electro-magnet.

THE PLATE HOLDER.

The metal plate holder is inserted at the opening in the periphery of the camera wheel, W, and carries two ordinary commercial sensitive plates 12 by 12 inches, which are inserted and withdrawn in the ordinary way. Two thin metal slides are provided which can be withdrawn after the holder is inserted and before the camera wheel is started to revolve. To enable plates of smaller size to be used when desired, each side of the plate holder has a metal nest form which can be inserted and takes an 8 by 10 plate.

Since the plate holder itself possesses considerable mass and is sometimes required to be revolved at high rates of speed, it is desirable to prevent any play between the glass plate and its holder. This is accomplished by tightening thumb screws in the holder which bear against the edge of each plate through the intervention of springs similar to those ordinarily employed in commercial plate holders. As already mentioned, the entire plate holder is firmly secured in position within the camera wheel, W, by four screws, CCCC, Fig. 2, which pass directly through the side frame of the holder itself.

TUBES AND COILS.

The particular shape and size of the tube for the carbon bisulphide and the constants of the coils to obtain the desired light upon the plate depend upon the electromotive force which is employed in the transmitter circuit and the resistance and inductance of the rest of the circuit, including the line.

These conditions being determined, a tube coil can be wound which will be most effective. During the tests of the chronograph, some account of which will follow, several tubes were made and used, but the one suitable for use in the ordinary case of taking velocities, and which was specially made with the chronograph, is shown at T, Figs. 2 and 3, and is wound of No. 18 cu. wire in four sections having an ohmic resistance in series of 12·7 ohms and in parallel of 0·84 of an ohm.

Inductance of four coils in series = 0·084 henry.
Inductance of four coils in parallel = 0·0052 henry.

THE NICOL PRISMS.

The size of the Nicol prism used as polarizer is 7·7 cm. long and 2·6 cm. in diameter. This is much larger than the one used as analyzer. The use of the condensing lens in front of the arc light makes it possible to use a much smaller analyzer, since the arc is brought to a focus at a short distance beyond it. The smaller analyzer also has the advantage of absorbing less light on account of its shorter length. The dimensions of the analyzer are 3·6 cm. long and 1·4 cm. in diameter.

TUNING FORKS.

A set of eight standard forks were imported from Koenig, Paris, selected as being suitable to cover the range of speeds which would ordinarily be employed for the sensitive plate in actual practice.

There are two each of 250, 500, 1,000 and 2,000 vibrations per second, one set to be used as standards with which to compare the others when they are used with the aluminum foil attached. The universal mounting for the different forks shown at F, Figs. 2 and 3, permits of an adjustment of the prongs of the fork for height and also transversely with respect to the optical T rail.

The lenses, L′ and L″, Figs. 1 and 2, besides being adjustable for height, as are the other lenses, have also a transverse adjustment to facilitate placing the image of the luminous hole in the foil upon the fork at the exact position desired.

THE MOUNTING OF THE CHRONOGRAPH.

To provide a firm support for all the apparatus, a solid brick pier was built upon a concrete foundation placed beneath the floor of the laboratory, and finally the base plate was set and leveled in suitable cement and firmly anchored down by four bolts about four feet long extending from the four corners of the base plate down beneath the floor.

PROCESS OF DEVELOPING THE PLATES.

No simpler manipulations in the art of photography can be imagined than those required in the use of the chronograph. In the first place no prints are ever required, the measurements being made directly from the negatives themselves. Since there are no lights and shades to look out for, as in taking ordinary views, where it is sometimes contrast which is desired and sometimes lack of contrast, the process of developing merely consists in pouring the liquid "developer" so as to flow the plate uniformly and quickly, and then rocking the tray until both tuning fork and chronograph records show plainly. The plate is then "fixed" in the ordinary way. Almost any developer may be employed, and there are many different kinds, some being two fluid and others one fluid developer. The two fluids are mixed just before developing. In practice the single fluid is more convenient, for it is ready at a moment's notice. Such a developer will keep for months if kept in glass stoppered bottles in the dark room. A formula which gives very satisfactory results is:

ONE SOLUTION DEVELOPER.

Water	100	parts or 10 ounces
Metol	1·5	parts or 75 grains
Sulphide of soda cryst.	10	parts or 1 ounce
Sodium carbonate cryst	10	parts or 1 ounce

or substitute for sodium carbonate cryst.,

Carbonate of potash	5	parts or ½ ounce

The metol to be dissolved in water before the addition of sulphite.

This may be diluted with water to suit the work in hand, the formula as given being very strong developer sufficient to cause an ordinary plate to flash up quickly.

KIND OF PLATES USED.

A rough calculation will show how very short is the time of exposure of any one point on the plate for the chronograph record. Supposing the width of slit to be 1 mm. at a distance 150 mm. from the center of revolution, and that the plate rotates ten times per second, the whole distance traveled by one point on the plate per second is $10 \times 2\pi \times 150 = 3{,}000\pi = 9{,}424{\cdot}8$ mm. The exposure is therefore 0·000106 second, for the point crosses the millimeter slit in this time. The desirability of having the most sensitive plates which can be made is clearly manifest. It is only the intensity of the light from the arc focused by the condensing lens upon the sensitive plate which makes up for the shortness of the exposure. This instrument affords a convenient way of testing plates, for the conditions may be almost exactly repeated for different plates. The same speed gives the same time of exposure. Some different plates were tried with a view of finding the quickest ones. No plates have been tried which equal the Stanley plate marked sensitometer 50 for quickness. These have, consequently, been used exclusively for the experiments.

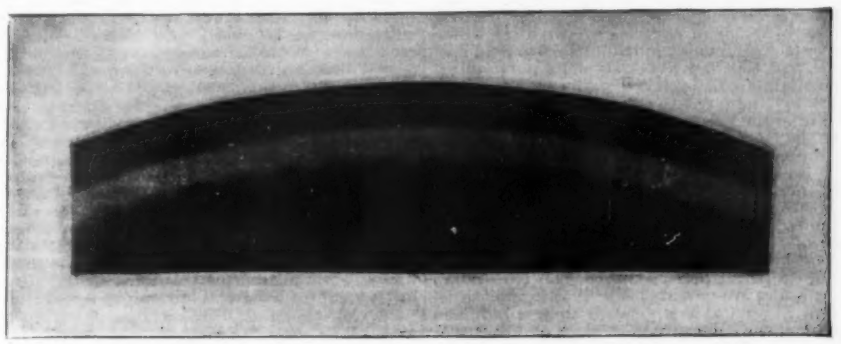


FIG. 5.—PART OF ACTUAL VELOCITY RECORD, 3·2 INCHES FIELD RIFLE BY "COMBINATION" METHOD.

Tuning fork 500 (single) vibrations per second.

THE MEASURING INSTRUMENT FOR THE CHRONOGRAPH.

After the negatives have been obtained by means of the chronograph, in order to determine velocities of a projectile or other moving body, measurements are taken from the negatives. For this particular form of record an angle measuring instrument is required, and a form of instrument specially adapted to the purpose was designed.

A view of this instrument is shown in Fig. 3. The parts are assembled upon a cast iron base plate, A, 24×27 inches, which rests upon three rubber legs, and although ordinarily should be upon a firm pier, it can, if desired, be easily moved and set upon a table for use at any part of the room. From the center of this base plate, A, is mounted the conical bearing upon which revolves the divided circle, the spokes of which are seen at SSSS, as well as the upper plane glass plate, B, 42½ cm. in diameter and 9 mm. thick, upon which the negatives are mounted when measurements are to be taken. The weight of the glass plate upon the conical bearing is relieved and adjusted by means of a vertical spiral spring in the top of the conical bearing itself.

The plate, B, and the divided circle thus revolve together upon the conical bearing, and can be turned

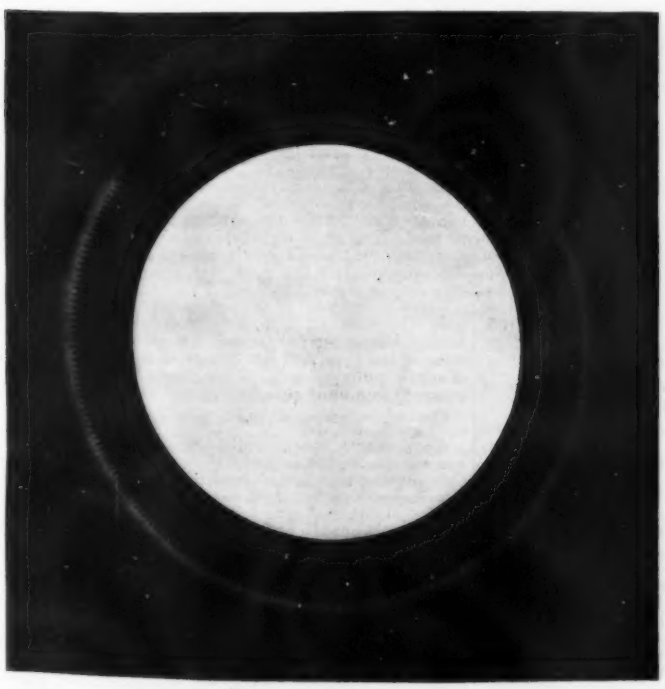


FIG. 4.—COMBINED CHRONOGRAPH AND FORK RECORDS.

Tuning fork 250 (single) vibrations per second. Actual size of plate 12 inches by 12 inches.

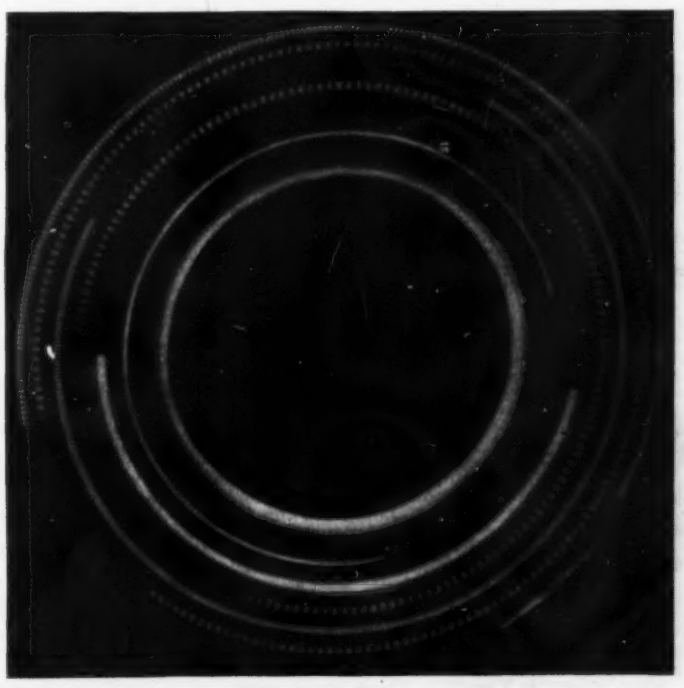


FIG. 6.—CHRONOGRAPH RECORDS OF THE ALTERNATING CURRENT UNDER VARYING CONDITIONS OF CIRCUIT AND SPEED OF PLATE. Actual size 12 inches by 12 inches.

by means of the four arms with spherical mahogany handles shown at HHHH, clamped in position by means of the hand screw, J, and given small motions by the tangent screw, K, with its spring cylinder, L. By means of the hollow milled screws, N and N', at right angles to each other, and their corresponding spring cylinders, O and O', the center of the large glass plate, B, has an adjustable motion in a horizontal plane with respect to the vertical axis of the instrument. This is accomplished by having the glass plate, B, mounted upon a second conical collar of considerably larger internal diameter than the external diameter of the main bearing cone, which collar slides horizontally on a plane surface with respect to the bearing cone, under the control of the screws and springs, N and N' and O and O'. The object of this independent movement of the plate, B, with respect to the axis of the instrument, is for the purpose of accurately centering the glass negative before readings are made.

The fine circle upon which the measurements are taken is made of silver, and divided by Messrs. Warner & Swasey's celebrated circular dividing engine. It has no graduation numbers marked upon it, and is protected from dust by the metal covering shown at M, which has its upper face graduated and numbered to read one-half degrees, and, together with a sliding pointer which moves with the glass plate, serves as a rough circle to read angles to half degrees, the finer readings being then taken from the silver circle beneath.

Bolted to the base plate are two uprights, DD, which support the cross piece, E, upon which the reading microscope, F, is mounted. This microscope has a motion of translation along a diameter of the glass plate by means of the rack, e, in which works a pinion operated by the thumb screw, f. This metal track, D', is screwed to the face of the cross piece, E, and dovetailed along top and bottom to receive the bearing frame of the reading microscope. Upon the top of the cross piece, E, two silver scales are mounted side by side, graduated from the central vertical axis outward along a radius in either direction, one reading to $\frac{1}{10}$ of a cm. and the other to $\frac{1}{10}$ of an inch, and by means of two corresponding verniers which move with the reading microscope, the radial distance of any setting can be read to $\frac{1}{100}$ of a mm. or $\frac{1}{1000}$ of an inch.

THE READING MICROSCOPE.

The axis of the reading microscope is inclined at an angle of 45° to the vertical axis of the instrument, to permit reading from a sitting position, and thus avoid the strain consequent upon prolonged readings directly from above. This is accomplished by means of an inclined metallic mirror inside the vertical barrel of the microscope which serves to reflect the light from the negative below into the eye of the observer at the eye piece.

The cross hairs for the microscope are placed across the lower end of the vertical barrel, that they may be adjusted as near to the negative as possible to give increased accuracy; and since the glass negatives vary considerably in thickness, the whole microscope can be raised and lowered by means of the thumb screw, g, and a scale for reading these relative heights is also provided. The system of cross hairs consists of two sets at right angles to each other, which have a relative motion in azimuth with respect to each other. They are mounted in separate collars at the lower end of the microscope barrel and are approximately in the same plane. By means of two pinions working in two cog wheels seen in the view and operated by two thumbscrews, h and h', on either side of the microscope, the two sets of hairs are moved in azimuth at will, and a circular divided scale, ii, reading to two degrees is provided by which the angle between the sets is known.

The advantage of this plan is that any arrangement of four hairs intersecting at a common point, found most convenient for the particular observer, or most desirable for accurate setting upon a particular form of record upon the plate, can be obtained by simply adjusting the thumbscrews, h and h', mentioned above. If the two sets are adjusted to coincide, we have the ordinary case of but two perpendicular cross wires visible, and from this to intersections at any angle with respect to each other, and also at any angle with respect to the sharp edge of the record which is radial upon the plate, are obtainable.

To make this microscope more elastic and applicable to a wide range of purposes, it is provided with two sets of lenses proper and three different eyepieces, giving combinations in magnifying power of 3, 7 and 10.

For the purpose of illuminating the negatives to facilitate setting, two plane mirrors, M' and M'', placed to reflect light directly up through the negative into the microscope, are attached; and by means of the handscrews, P and P', these may be adjusted to the proper angle to so reflect the outside light.

THE MICROMETER MICROSCOPES.

Instead of verniers and magnifying glasses for reading the angles, the much more convenient and accurate micrometer microscopes shown at R and R' are employed. As in the reading microscope, these are mounted with their axes inclined at an angle of 45° with the vertical axis of the instrument, so that all observations both for angles and for settings upon the record are conveniently performed by the observer from a sitting position and without moving. This is accomplished by means of totally reflecting prisms, S and S', which reflect the light from below into the eye of the observer at the eyepiece.

Through the outer rough circle, M, two windows are cut beneath the reflecting prisms of the micrometer microscopes, by which the illumination of the silver scale beneath is obtained from the light passing through the translucent glass cylinder, T and T', and through these windows is the only way by which this scale can be observed. To prevent any particles of dust from collecting inside the tube, the lower end of each of the translucent glass cylinders is provided with a circular cloth screen extending to the surface of the outer scale circle, M. These are shown at u and u'.

To enable the instrument to be used at night as well as in daylight, the translucent cylinders can be artificially lighted by means of two small incandescent electric lamps shown at V and V'. These lamps require about five volts and one-half an ampere to secure a good illumination of the scale beneath.

The silver scale is divided to read to tenths of a degree. The decimal division of a degree is preferred to minutes and seconds, because if the readings were taken in minutes and seconds, they would have to be reduced to the decimal system in computing velocities.

The micrometers, WW', are divided into twenty parts, and since five revolutions of the micrometer screw correspond to one small division upon the scale beneath, the micrometer reads directly to one thousandth of a degree, and by estimation to tenths, to one ten-thousandth of a degree.

CENTERING THE GLASS NEGATIVE.

The circles which appear upon the tuning fork records and are produced by the fine wires in the camera already described are for the purpose of accurately centering the plate before any measurements are taken. This obviates any necessity for centering the plate itself when in position in the camera.

The negative is laid film side up upon the glass plate, B, approximately centered and held in position by the four spring clamps, cccc. By means of the traversing screw, f, the reading microscope is moved until the tuning fork record comes in the field of view, and then by means of the hand screws, N and N', the plate, B, with negative is moved until the intersection of the cross hairs remains upon any one of the circles of the record during an entire revolution of the plate. The negative being then centered, the reading microscope may be traversed to show the chronograph record, and the setting made for the final readings of the angle by means of the micrometer microscopes already explained.

In considering this instrument as a whole, it is evident that it has a wide range of use other than that for which it was particularly constructed. How it can be employed either to divide or to test the division of graduated circles will readily be seen by those interested, and the convenience and arrangement of the various parts, and especially their simplicity, it is thought will commend this form of angle measuring instrument for a general laboratory apparatus.

SOME FURTHER EXPERIMENTS WITH THE CHRONOGRAPH.

During the progress of the installation and testing of the new instrument an opportunity was presented for some further experiments with it, both along the line of simplification in manipulation when used for the single purpose of measuring projectile velocities, and also some other experiments of a more purely physical interest.

The design of the chronograph is such that it may be used for a variety of purposes not only as a chronograph, but also as an instrument for the investigation of problems which are met with in the laboratory, such as the study of alternating current phenomena, the study of the rate of motion of almost any body, the recoil of gun carriages, and many others which suggest themselves to the reader. The pleasure experienced in using a well made instrument with all its fine adjustments can well be appreciated after one has been obliged to use the homemade apparatus with which the original investigations were made.

The source of power which was permanently installed to operate the chronograph consists of thirty-eight storage cells, which are charged at regular intervals by an Edison dynamo driven by a steam engine. The use of these cells for the chronograph does not prevent them from being available for the general laboratory uses of the Artillery School, as well as for furnishing the electric lighting for the electrical and chemical laboratories, the machine shops, boiler houses, and also for operating the two Boulengé chronographs already at the post (thus supplanting the Edison-Lalande battery), the post telegraph and fire alarm systems (supplanting the large number of gravity cells formerly used), besides electric fans, etc.

Since the storage cell has an internal electrical resistance practically nil, they can be drawn upon independently for all these purposes at the same time, or by means of a general switchboard each circuit can be cut out or in at pleasure.

Two new No. 8 copper line wires, extending from the instrument to the new 10 inch disappearing gun battery about 1,100 yards distant, have been put up and are ready for use.

EXTERIOR VELOCITIES WITH THE 3·2" FIELD GUN.

For the purpose of the preliminary tests with the new instrument and to determine the constants of the gravity switch, the field gun was again utilized as being most convenient, and on August 4, 1896, the first actual velocity was taken. But four screens were employed, and these were placed at about ten foot intervals. The revolutions of the plate were 658 per minute, and the strength of current employed for the transmitter circuit, the four sections of the tube coil being joined in parallel, was 13½ amperes. The same construction of screens and means of restoring the transmitter circuit between screens was employed as is described in the first paper, and were all that could be desired for the purpose. The general appearance of the record is the same as has been shown in previous records, except that with a sensitive plate twelve inches square the linear distance between consecutive records, representing ten feet on the proving ground, is much greater than formerly, and permits, therefore, even greater accuracy in measurement.

SIMPLIFICATION IN THE USE OF THE INSTRUMENT FOR PROJECTILE VELOCITIES.

To avoid the necessity of being obliged to cause the projectile records communicated by the transmitter to occur during the passage of the camera drop shutter in its fall, which limits the total time of exposure of the plate, it is very desirable to be able to dispense with this shutter in ordinary practice in simply taking velocities, employing only the crossed Nicols to prevent the light beam from entering the slit before the transmitter circuit is made.

We are thus relieved of any uncertainty due to non-uniformity in the action of electric primers, or the difference in the "time interval" between the making of the primer circuit and the projectile reaching the muzzle for different guns, which intervals though ordinarily considered small are not so when compared with such intervals as are met with in ballistic experiments; and we are assured that whatever happens in the transmitter circuit will surely be shown upon the plate in any case, no matter what gun is being used.

If we also have some means of controlling the exposure of the tuning fork record without operating the camera shutter, and causing this record to be made upon the plate simultaneously with the chronograph records, we have an ideal simplicity in operation for taking projectile velocities.

A method which has been shown by trials to be entirely satisfactory is the following: The mounting for the fork, F (Figs. 1 and 2), is simply transferred to the same optical T rail with the lamp and tube and placed between the analyzer and the receiver. The lens, L'', which is used upon the fork rail for focusing the luminous hole in the aluminum foil upon the plate, is also placed upon the tube rail, and used to condense the light which comes through the tube upon the edge of one prong of the fork, which is now used without the aluminum foil attached and properly adjusted in the path of the beam so as to intercept one side of it. The short focus lens, L', is now used to form a sharp and magnified image of the edge of the fork upon the slit.

By this simple arrangement we see that each chronograph record becomes its own time record as well, and when once the fork and the lens, L', are adjusted, the operator need have no further concern during a series of observations upon the same plate in regard to securing the time record, other than providing that the fork shall be vibrating at the instant an observation is to be made, and this too is made entirely automatic and perfectly certain of execution.

The available space for other records upon the plate is now more than doubled, and there is no possibility of associating the wrong fork record with any particular gun record, but if desired a long series of observations can be taken without ever removing the plate holder from the camera wheel, and in regular succession from outside inward or vice versa, by simply traversing the rail slightly between shots by turning the traversing hand screws provided for the purpose.

When it is desired to use the camera in this manner without operating the drop shutter provided, it is only necessary to secure the shutter temporarily in any position so that its opening shall uncover the slit, and to close entirely the round opening for the fork record on the opposite side.

To prevent the daylight of the room from fogging the plate through the open slit—and it would have an especial opportunity if the slit should be exposed to it during several revolutions of the plate before the gun was fired—it is desirable to provide means by which the time between the instant at which the gun is fired and the slit itself exposed shall be as short as possible, and fortunately this is accomplished very easily.

All that is necessary is to pull a simple hand switch which will close the transmitter circuit, to admit the light through the tube upon the plate, at the same time that the primer circuit is closed to fire the gun. The same battery which is used for the tube is also used to fire the primer.

From this it is but a natural step to attach to this same lever the wedge which plucks the fork, and we have reached the point at which the whole operation of taking with certainty observations for velocities at any number of prepared points either outside or inside the gun consists in simply moving one hand lever.

The lamp is kept adjusted and the camera wheel constantly revolving so that whenever the telephone from the proving ground announces that the shot can be fired, the chronograph operator accomplishes all with the simple act above described. Furthermore, this plan permits of all this information being recorded upon the plate by means of but two line wires from the chronograph to the gun, which may be any desired distance away, because the same wires may now serve for the primer and transmitter circuits, they being closed at the same time by the movement of the firing lever. By this means we have upon each record the additional information of the exact "time interval" between the making of the primer circuit and the instant the projectile reaches the muzzle or first prepared screen, which "time interval" varies for different guns, kinds of powder, etc., and is a constant itself of considerable importance, especially in naval gunnery from a rolling platform.

Numerous tests were first made to prove by actual trials whether, when the Nicols were set for extinction, this served as a sufficient screen to prevent the powerful beam condensed down the tube from still being able to fog the plate after a time sufficient for several revolutions of the plate, as also to determine to what extent the ordinary daylight of a room must be screened off to secure clear records without traces of fog. The small slide windows in the wooden face cover of the camera are convenient means of making the exposure by hand when the inside drop shutter is not operated.

In Fig. 4 are shown some of the "combination records" by the method described above in which the tuning fork 250 (single) vibrations per second is employed. The plate was revolved slowly by hand which accounts for the saw-tooth appearance of the record. The exposure for this plate was made by the slide window above referred to.

Fig. 5 shows part of an actual velocity record by this plan with the 3·2' gun, in which the tuning fork 500 (single) vibrations per second was used. The four sections of the tube coil were joined in series and a current of seven amperes used in the transmitter circuit to increase the amount of light through the analyzer.

SECOND METHOD.

Another way to accomplish the result above described has some advantages over the one just mentioned; for this allows a tuning fork record to be taken as formerly. The former turning fork records with their fine intersection points by which measurements are made are difficult to improve upon, and some advantage is gained by retaining it. This may be done by having the shutter for the tuning fork record work independently of that for the chronograph record. The chronograph shutter is then left permanently open, and only the Nicol prisms and tube used for a shutter as previously described. The gravity shutter is used for the tuning fork which is released when the lever is pulled to fire the gun. This gives an independent time record as formerly, and if many exposures are made on the same plate care must be taken to be sure which records go together. The chronograph record with the exception of the one wavy edge will be the same as last described. The transmitter circuit is made with the

primer circuit, and the "time interval" of the particular gun used is recorded on the plate as before.

SOME CHRONOGRAPH EXPERIMENTS WITH ALTERNATING CURRENTS.

The enormous commercial development of alternating currents during the past few years has necessitated a thorough study of the phenomena connected thereto. The great difficulty which has stood in the way of experimentally recording by a continuous method, not a method by points, the instantaneous values of an alternating electric current which is changing its direction hundreds of times a second, at present constantly met with in practice, has prevented in a great measure direct experimental evidence being obtained to verify and corroborate many of the conditions which theory points out should exist.

This experimental problem becomes much more difficult when we attempt to determine and record what happens in a circuit carrying an alternating current when it is suddenly altered in some way, as for instance when it is made or broken. The fluctuation of the current under varying conditions of the circuit as to its resistance, inductance and capacity when the circuit is made has been theoretically deduced when the electromotive force is truly harmonic, and this case is especially worthy of experimental evidence.

Any "method by points" depends fundamentally upon the supposition that the fluctuations in current repeat themselves exactly in successive alternations, and evidently this is far from being true for the important cases just mentioned.

The employment of a continuous method of recording, not involving the movement of any ponderable matter, and therefore without inertia in the production of the record, which is the fundamental principle of this chronograph, gives indications therefore in accurate phase with the fluctuating current, no matter how rapid these changes may occur; and since the time scale is also accurately recorded upon the plate by means of the tuning fork record, we may consider each negative obtained as a qualitative graphical representation of the varying current, automatically plotted in terms of the two variables, time and intensity.

As illustrating the delicacy of this apparatus as a means of investigating purely physical problems, a study has been made of the interesting cases of "make," for an harmonic electromotive force, in circuits under varying conditions as to inductance, resistance and capacity, and important theoretical relations verified. A detailed account of these experiments is given in the complete paper in the United States Artillery Journal.

CONCLUSION.

In closing this paper, which in the sense that a chronograph based upon this new principle has now been constructed, installed and tested in actual practice, naturally marks a distinct step in its progress, we cannot refrain from submitting a few observations both upon its future field of usefulness as a military instrument of precision, and also some of a more general character which have been specially emphasized during the progress of the experiments. The experiments thus far recorded have necessarily been of a disconnected and superficial character, both on account of being always obliged to subordinate this work to other regular routine duties which have been exacting, and because it has been impossible to be together for but brief periods at wide intervals apart. This accounts in part for lack of consecutiveness and systematic thoroughness of treatment, which is much to be desired in physical research. But in using the small time thus far available, the object has been rather to indicate the range of application of this new instrument than to exhaustively treat any one application, in the hope that in the interest of science others having more time and facilities than ourselves may possibly be induced to work with it and to themselves discover new fields for its use.

GUNNERY PROBLEMS.

From one point of view it may, perhaps, be said that the greatest difficulty which the ordnance engineer has to contend with is that he is required to design and construct for a class of phenomena distinct in themselves, which are so rapid in their action and effects that all ordinary methods and tests of material cannot be relied upon for safe constructions without uncertain and undetermined factors of safety. Where the bridge engineer is supplied with accurate data the ordnance engineer is involved in more or less theoretical hypotheses. At this time not only is the actual amount of pressure developed in a gun undetermined, but the progressive effects of this pressure upon the various tubes and hoops of a built-up gun is also a mooted question.

The reason for this, it is needless to mention, is that, since there is no blow, however sudden, but which is progressive in its action, reliable experimental data are not obtainable, because the unit of time which can be reliably and consecutively recorded and measured is too great for the class of phenomena involved. It seems then that throughout ballistic experiments from the motion of the projectile to even the behavior of the carriage under fire, the one essential element where the greatest error should occur in the data is in the measurement of the time.

THE UNIT OF TIME.

From a physical point of view it may be remarked that the time unit, unlike the units of length or mass, is in a sense a derived unit. Unlike the standard meter or gramme, which can be directly examined, compared and copied, we can have no direct model of a second, but must derive the unit second by observations upon the motion of some standard body, such as a pendulum or the earth. This process of observing the motion of the standard body involves the recording of the exact instant between two or more points of the motion of the body which successively repeat themselves. Ultimately then, where we are concerned with very minute intervals of time, the reliability of the method depends largely upon the ability to produce a record of the phenomena at a distance as nearly simultaneously with the occurrence of the phenomena itself as possible. Divested of details, it may be said that the essential point of this chronograph whereby it is thought a distinct advance is made is, that it places the reliable measurement of minute intervals of time upon a new basis and opens up in consequence a range of experiment hitherto closed.

EXTERIOR VELOCITIES.

Although not yet actually accomplished with guns of larger caliber for lack of opportunity, yet there is no reason to doubt that ordinary exterior velocities can now be taken within a few feet of any of our modern guns regularly mounted in barbette or upon disappearing carriages. This will permit measurements, which have heretofore been limited to a proving ground on account of the great height and distance of ballistic screens which would be necessary in front of a modern parapet, to be taken directly upon the parapet, at any fort and at any time in connection with the regular gun practice.

Although the blast of a modern high power gun is terrific in force, yet when the prepared points can be as near together as is desired, the problem is at once shifted from the chronograph itself to the distant gun, where it becomes a matter of constructing such a metal screen frame as is found necessary by trial to withstand the blast, being always assured that whatever the projectile causes to happen in the transmitter circuit will be found faithfully and accurately recorded upon the receiver of the instrument. For instance, there is no reason, if it is found necessary, why a steel screen frame a few feet in length sufficient to bear three or four small ballistic screens could not be constructed and made attachable to a permanent bed plate foundation upon the parapet itself, or better than this, that a distance of four or five feet of the length of the bore of the gun at the muzzle be permanently prepared during fabrication with perforations such as Nobel and Able employed to be used for taking velocities whenever desired. This would not materially impair the efficiency of the gun, and since the interruptions in the transmitter circuit would then always occur at the same carefully prepared points, not only would the calculations be abridged but the transmitter circuit would be complete by attaching flexible wires to permanent binding posts upon the side of the gun chase.

Furthermore, since it has been shown in the case of the 3·2" field rifle,* that the velocity of the projectile from the muzzle of the gun to a considerable distance along the trajectory passes through a maximum value, it seems that the meaning of "initial velocity" should be more carefully defined, especially as the acceptance or rejection of a lot of powder from the manufacturer sometimes depends upon a very few feet more or less of initial velocity shown under test.

INTERIOR VELOCITIES, ETC.

Opportunity has not yet been presented for further experiments with larger guns upon the motion of projectiles inside the bore of the gun, a subject the importance of which is unquestioned, since the chronograph at the artillery school is the only one as yet installed.

As stated above, the problem to be attacked for these guns is now at the gun and not at the chronograph, and it is hoped that this work can soon be seriously taken up at a proving ground where facilities for systematic and continuous work are available.

It may be remarked that projectile velocities are greater than those of any other body propelled by engines made by man, and the direct experimental study of their motion is, in consequence, correspondingly difficult. To obtain observations such as have already been given in a previous paper upon experiments inside the bore of the 3·2" field gun, it was necessary to deal with a unit of time which bears about the same relation to a second as a second does to a third of an hour. In the case of the study of the recoil of gun carriages or the motion of pistons in hydraulic cylinders in general, the velocities being inversely as the masses, these motions are then so slow, when compared with that of the projectile, that they should easily yield to a thorough experimental treatment.

Furthermore, if the motion of a projectile through the bore can be determined by a direct dynamic method, a gun would seem a good physical apparatus with which to study the laws of the thermodynamics of gases under adiabatic expansion.

A LABORATORY APPARATUS.

The brief account given in this paper of the application of this chronograph to the study of purely physical problems in the laboratory indicates, it is thought, its usefulness in this field. The rapid advance which alternating currents and alternating current machinery have made in the industrial world has led to a thorough theoretical study of the subject, but the experimental verifications have been attended with difficulty on account of the very rapid changes in current which must be continuously followed and recorded even with the lowest commercial frequencies. This difficulty is multiplied many times when, as in the experiments above, it is attempted to follow what happens during the very short interval after the "make" of an alternating current in a circuit containing varying conditions as to resistance, inductance and capacity.

The design of a chronograph based upon this principle for general physical laboratory purposes would probably differ in some respects from the one described in this paper, and possess attachments and adjustments not provided for in this instrument, but when carefully considered from this point of view, it is thought that this chronograph would prove a most useful apparatus in the equipment of a physical laboratory.

* Experiments with a new Polarising Photo-Chronograph.—Journal of the United States Artillery, vol. iv, No. 2.

A PATIENT'S ACCOUNT OF THE PARIS PASTEUR INSTITUTE.

THE Institut Pasteur is a substantial and handsome building, standing in a large garden with stables, kennels and lapinière in the rear. It occupies a freehold site in the Rue Dutot, a street off the Boulevard Vaugirard, in a district on the south side of the Seine, remote from the fashionable center of Paris. One side of the main building is occupied by the private residence of Mme. Pasteur, the widow of the illustrious founder of the institute. On the other side are a magnificent scientific library and the laboratories where work chemists of all nationalities. It will be understood that these laboratories, where experimental work is carried on, are entirely distinct from the hospital section of the institute devoted to the "antirabique" treatment. In the former, as I understand, experiments in different stages are now in progress for the treatment of croup, cholera, snake bite, etc. The gardens surrounding the institute are pretty and well kept, and here the patients lounge about and take their ease until the doctors arrive and the day's treatment begins.

About a quarter to 11 the day's performance begins. The concierge, a good looking, soldierlike fellow, with Napoleonic mustache and imperial, has struggled into a semi-military uniform, and stands sentry at the door of the doctors' room, and the great hall is filled with an expectant crowd of all ranks and conditions of men. There are seldom less than sixty to eighty patients under treatment. Every day some new ones put in an appearance; every day some, their treatment completed, go, with hearty handshakes and good wishes. On the wall of the great hall hang announcements that "The anti-rabic treatment is entirely gratuitous," "The institute is supported by voluntary contributions." Patients wishing to subscribe are referred to the secretary's office. Whether they contribute or not is a matter between their consciences and their pockets; no knowledge of the subject comes into the operating department, nor, if it did, would the impartiality of the treatment be affected.

There is no priority under "la piqure" but the priority of the newest patient. There is not now the mixture of nationalities at the Pasteur Institute that was observable a few years ago. Spain, Italy and Russia have all their own institutes, and the weary pilgrimages from these lands are ended, but in rank and condition, age and sex, the variety is endless and amazing.

The noise in the hall is increasing; a group of good looking peasant girls are flirting, as good looking girls will, with a crowd of lads: the flirtation degenerates into a romp, and the racket gets rather pronounced, so that one looks anxiously toward Napoleon, but he is a good natured fellow and beams benignantly on the giddy young things. Presently he gives a stentorian shout of "Les Nouveaux," and silence settles down. It is the signal for new patients who have not yet undergone treatment to pass into the salle d'inscription for particulars of their cases to be taken down in the register. The examination is searching, and results in the institute becoming possessed of most facts of your family history and of the dog's as well, so far as the latter are ascertainable. The interrogatories are, of course, in the first instance, directed toward ascertaining the bare facts of each case, in order to prescribe the course of treatment. Fifteen days is the minimum period, which in more serious cases is extended to eighteen or twenty-one days. The number and position of the bites and the length of time which has elapsed before the patient reaches the institute are all factors in determining the result. In very severe cases what is called the "intensive" method is resorted to, a treatment which is admittedly not without risks. The prescription of the course of treatment is entirely in the discretion of the surgeon, but the broad rule is that a bite in the leg is the least important, a bite in the hand is somewhat more serious, and most dangerous of all is a bite in the head or face. If the dog have bitten one through one's clothes, and if the clothes have or have not been torn thereby, are also points which have to be clearly stated. Much of the information taken down is, however, required for statistical purposes. Although the institute refuses no case in which there is any suspicion of rabies, it is careful to classify its cases, according to the weight of evidence, thus:

Class A—Includes cases in which the biting animal has been proved by experimental inoculation to have been rabid.

Class B—In which a veterinary certificate of rabies has been provided.

Class C—In which no inoculation or veterinary examination has been made, but in which there was strong reason to believe that rabies existed.

The great element of doubt exists in the last named class, and it is not surprising to note that over a long period of years the smallest percentage of deaths, 0·33, occur in Class C. A veterinary certificate is, as a general rule, good evidence.

After the new patients' cases have been duly entered, the surgeon passes into the operating room, and a stentorian shout of "Preparez-vous" brings the waiting crowd to attention. Cases are treated in batches, the new being first attended to, and the others going in according to the stage of inoculation they have reached. After the inoculation, patients whose wounds are unhealed pass to another room, where they are dressed.

Each day at least one rabbit dies, the body is laid on ice, and, as soon as possible, dissected and the spinal cord carefully removed and suspended in a glass bottle, the bottom of which is covered with a layer of caustic potash for the absorption of moisture. The bottle is labeled with the date and put away in a cupboard in a room kept at an even temperature, from which daylight is always excluded. Each spinal cord will supply material for about thirty inoculations. The fluid for inoculation is prepared by crushing a small piece of this dried cord with rather more than six times its bulk of sterilized veal broth. From one to three cubic centimeters (fifteen and a half to forty-six and a quarter drops) of the fluid are used for each inoculation. Patients are inoculated in the sides, which are first dabbed with a solution of perchloride of mercury, and on the first day of treatment they receive injections on both left and right side of virus that has undergone fourteen and thirteen days' drying. This mild preparation confers protection against the effect of the second day's inoculation, for which virus of the twelfth and eleventh days is employed. On the third day, ninth and tenth days' virus is used. After the fifth day the inoculation is made on one side only. By that time the virus of the sixth day's exposure is reached. Every day's treatment up to the ninth day shows a progressive increase in the strength of the virus, each injection conferring immunity against the effects of the stronger one by which it will be followed. On the ninth day the patient receives an injection of the most virulent virus used, that of the third day's exposure, which is fully equal in activity to the bite of a rabid dog. After that a somewhat less active virus is employed until the fourteenth and fifteenth days of treatment, when virus of the fullest activity is again used.

This is the ordinary treatment. Under the "inten-

sive method," the operations are in the beginning repeated twice daily, so that four days' strengths of virus are used each day, the result being that the more virulent preparations are reached in a hazardously short space of time, so that the risk of the patient's constitution standing the strain is an appreciable one. This treatment is only resorted to in cases of great severity.

All rabies statistics are more or less unsatisfactory, and it is difficult to arrive at any very exact figures as to the proportion of deaths that occur in cases where no precautionary measures have been adopted. The truth probably is that of persons bitten by rabid dogs six out of ten escape without very ill effect. The odds of six to four in one's favor in the race between life and death are not heavy, and if the Pasteur treatment can, as its latest figures show, increase them to three hundred to one, I think the Pasteur system will be held to have proved its value.

The charge has been made against Prof. Pasteur that "he has invented a new disease, the addition of paralytic symptoms to the old hydrophobia." There is nothing new in dumb rabies. It is the all but invariable form the disease takes with rabbits, while it is unusual in dogs and human beings, who generally develop rabies or hydrophobia in the raging form. That the patients who succumbed under the intensive treatment should have shown paralytic symptoms is curious, but similar cases were recorded long before the Pasteur treatment was established.

It seems probable that these deaths were due primarily to want of proper care, especially in the avoidance of cold. The defect of the system at the Pasteur Institute is the total absence of any direction to the patients as to the rule of life to be observed while under treatment. The only point that is impressed upon them is that they should take frequent warm baths. And, from the mixed nature of the company, this recommendation is perhaps made as much in the interest of the doctor as in that of the patient. Nothing, however, is said, by way of warning, against catching cold, and it seems almost certain that where paralytic symptoms have set in they have been the direct result of a severe chill taken in the middle of the treatment. Doctors of all nationalities are unanimous in the opinion that the treatment causes no pain or inconvenience. I do not find, however, that any of the doctors have ever undergone it. While it is quite true that no permanent painful consequences result from "la piqure," it is equally true that it causes at times a good deal of local pain and discomfort. Children, on the whole, bear it best, and get soonest hardened to it. I have seen two cases of boys who fainted dead away on the first inoculation, who by the third or fourth day were perfectly indifferent to the whole process, left off their games to go in the "pique," and came out to resume them with grins on their faces. Persons of maturer years, especially men of full habit, occasionally suffer a good deal from inflamed and swollen sides, and poultices and hot baths are the only alleviatives. A conviction of the unimportance of the symptoms makes the doctor serenely indifferent to the patient's sufferings, which are sometimes accentuated by needlessly rough handling. Apart from merely local affections, the only noticeable effect of the treatment seems to be a tendency, more or less pronounced in different individuals, to cramp in the limbs, a modified form, it is to be assumed, of the paralysis of dumb rabies. But these symptoms seldom last longer than two or three days.—Correspondent New York Sun.

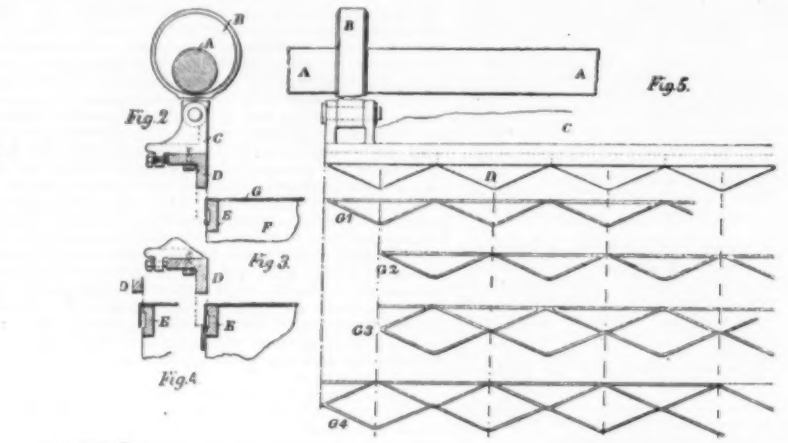
EXPANDED METAL.

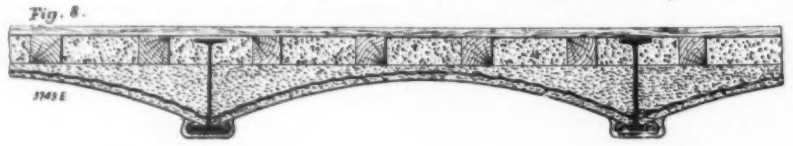
AT the recent meeting of the British Association, held in Liverpool, "Expanded Metal" was explained in a paper read by Mr. Golding. The device consists in slitting a metal sheet so as to form what may be popularly described as a trellis work.

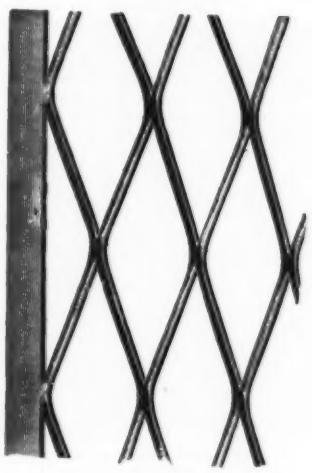
In Figs. 2 and 5, A is the main shaft, on which are forged two eccentrics, one of which is shown at B. These eccentrics are connected with the main sliding head of the machine, C, which carries the upper corrugated cutter, D. In Fig. 2, E represents the lower cutter blade of the machine, resting in the bed of the machine, F, and G of the same figure indicates a sheet of metal lying over the lower cutter blade, E. The operation is as follows: The plate, G, is fed over the lower cutter, E, the distance required for the width of strand to be produced, and by means of a clamp is held tightly against the cutter. The corrugated cutters, D, are then made to descend, and to both slit and stretch the projecting part of the plate, G, in the manner shown at G 1 in Fig. 5.

The corrugated cutters, D, in Fig. 5, are represented as having made this descent, and having again been raised to their position of the highest throw. G 2, in Fig. 5, shows the metal plate thus first acted upon as having been shifted longitudinally one-half of the distance represented by the length of one mesh, and, at the same time, again fed forward and over the under cutter, E, the distance required for the width of the mesh, as in the first instance. The sheet is then again clamped, and ready to be acted upon by the upper cutters, D, in a similar manner to that first described. It will be observed that the points of the cutters, D, at this time encounter the metal to be cut and stretched, at and back of the spaces left uncut by the first operation. The width of the metal at this uncut space is twice the width of the strands, and as the entire cutters, D, descend, they have no effect whatever upon the meshes first produced, except to carry them downward, as shown at G 3, in Fig. 5. The action of cutters, D, in Fig. 3, indicated by the dotted line below them, has been to make these incisions through the metal, and permit the plate to again be returned to its first position, as is shown by G 1 and G 4, Fig. 5. The feeding device of this machine is so devised that the widths of the strands are readily changed, and any thickness of metal may be thus cut and stretched, the only limitations being the strength of the machine and the resistance of the cutters.

In practice, sheets of metal ranging from 24 B. W. G. to ¼ in. in thickness and of 8 ft. in length are employed. The sheets may be of any width, and the expansion is from two to twelve times the original width of plate, according to the size of mesh and the width of the strands produced. Mr. H. B. Tarry, the general manager of the Expanded Metal Company, Limited, of 39 Upper Thames Street, who are the proprietors of the invention, has submitted for our inspection some examples of their work, and drawings of a few of its very numerous applications, from which we have prepared the illustrations, of which Fig. 6 gives an example of the finished sheet. By far the greater consumption of the metal under the old process of manufacture was for lath and plaster work, or rather for a method of construction that was substituted for lath and plaster, as the expanded metal can hardly be described as lath. In Fig. 7, which is taken from a sample specimen, the method of using the expanded metal for this purpose is shown, and it will be seen how well the plaster or cement is incorporated with the metal work. Panels of this description can be very well used as solid partition walls, being generally finished up to a total thickness of 2 in. A quick setting, hard, and non-corrosive cement, such as granite silicon plaster, is preferable; and with this it is claimed







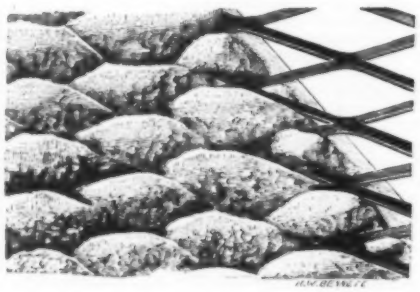
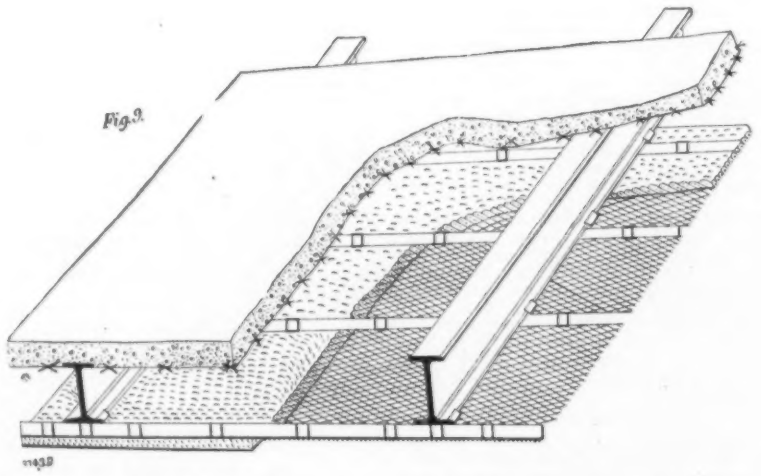


FIG. 7.

FIG. 6.



a strong partition, fireproof, verminproof, and practically soundproof, is obtained with the thickness stated. Fig. 8 shows the method of utilizing the expanded metal in the construction of segmental arches, the addition of the metal being said to add greatly to the strength of the concrete structure, so much so that it may be used for the heaviest warehouse purposes. Suspended ceilings may be added for the purpose of giving flat effect and affording opportunities for placing ventilating or heating pipes. The expanded metal may also be used for flooring, wherein it forms a binder for concrete. This is effected by placing the heavier and larger meshes of the metal upon flat centering, and then spreading the concrete on it. In this way the under surface is given the tensile strength of the expanded metal.

Sir John Fowler and Sir Benjamin Baker have reported on this method of construction. They experimented by breaking down concrete slabs and arches by slowly weighting them with rails, one set of slabs being made without the metal and two sets with. Without the expanded metal, slabs which were 3 ft. 6 in. in the clear span gave way when loaded to 2·57 cwt. per square foot as a mean of two experiments. When an expanded metal made from mild steel, and having a 3 in. mesh and strands $\frac{7}{32}$ in. by $\frac{5}{32}$ in., was incorporated in the structure, the breaking load rose to 15·86 cwt. per square foot as a mean of two experiments. With a somewhat stouter metal the load was brought up to 19·28 cwt. per square foot. With a 6 ft. 6 in. slab the corresponding figures were 0·46 cwt., 4·61 cwt., and 5·07 cwt. per square foot, the former, of course, being for the slab without expanded metal. The report goes on to state that "the use of the expanded metal in the case of the 3 ft. 6 in. span increases the strength of a flat concrete slab from six to eight times the strength for carrying a uniform load over that it would have if made without expanded metal, and in the case of the 6 ft. 6 in. span the strength is increased to ten or eleven times." In testing these slabs Messrs. Fowler and Baker found that, in regard to strength, slabs without the metal did not approach those with the metal, and even with a neat cement slab, which would cost as much as the concrete and metal slab, the strength was much inferior. The report goes on to say: "The quantity of concrete per square foot, and therefore the weight, in the case of the slabs, is two-thirds of that in the arches of the same span and minimum thickness at the crown and with a rise of one-fourteenth to one-fifteenth of the span. This fact points to the utility of expanded metal in conjunction with concrete in flat slabs as a material for flooring."

Fig. 9 illustrates a method of constructing a concrete

and expanded metal floor with a suspended ceiling attached, the ceiling bars being 12 in. apart. In fencing, a strip, say from 1 in. to 2 in. in width, is left, and forms the top rail; this strip remains at nearly right angles to the meshes, and so is in a position to resist pressure coming against it, while the truss-like form of the metal supports it from beneath. This is convenient for application to wooden standards. When used with vertical meshes, and applied to iron standards and parallel bars, the metal forms a fence which is ornamental and practically unclimbable. In the first instance, the rigidity of the metal is maintained by its being stapled to the wooden posts, and in the latter case, by crossing the parallel bars in the direction of its greatest rigidity, which is always transversely to the length of the meshes. In one direction the metal may be coiled to form circular inclosures. Tree guards of almost any desired diameter, and up to 8 ft. in height, are thus made from single sheets of the metal, not necessarily requiring bars or standards. An advantage claimed for the expanded metal is that, in consequence of the absence of joints, when painted or galvanized, every part is completely coated, and there are no unprotected interstices in which water can lodge and produce oxidization. The foregoing description refers almost entirely to expanded steel, but expanded brass is becoming a staple article of manufacture, while aluminum sheets are also being largely treated by the same process.—We are indebted to London Engineering for the article and engravings.

CANET'S CONCENTRIC RING BREECH APPARATUS.

AMONG the newest type of breech-closing apparatus of M. Canet is one combining in a striking way the characteristics of novelty and simplicity. It is known under the name of the concentric groove breech piece, and, while it essentially differs from the wedge and screw systems, it claims to combine the advantages belonging to each.

The breech block itself is shown in Fig. 2. The closing block is roughly of the form of a half cheese, the cut portion forming the diameter being hollowed out as shown, and the two flat faces being cut into concentric grooves, either triangular as in figure or square cut. These are made to move in corresponding grooves cut in the breech of the gun—see Fig. 1. The block when the breech is closed is in the position shown in Fig. 2 and Fig. 3; that is, the hollowed or diameter face is toward the rear and the curved face toward the bore. In this position the block is supported against the pressure of the powder gas by the bearings of the concentric rings in their grooves. When turned round by means of the lever handle the hollowed side leaves an open passage for the shot into the bore, as shown in Figs. 4 and 5. The long lever arm by which the breech piece is worked moves in a vertical plane on the right side of the gun. The short piece or neck is a half cylinder, and moves in the recess as shown in Figs. 4 and 5, moving on an axis passing through the centers of two systems of concentric grooves, so as to accomplish the opening and closing movement shown in the figures. The extent of the movement is limited above by contact against the gun, and in the backward direction by the head of a screw fitting into the lever. On the end of the long arm of the lever is a locking bolt, which secures the breech piece when it is forced home.

Firing is effected by percussion or electricity, or by both together. In the first case, which is that of the example here depicted, the mechanism is repeating; that is to say, it provides for the same tube being struck repeatedly without altering the position of the breech. It contains a striker, moved by a V-spring, acted on by a trigger with two arms, of which one carries a ring for a lanyard. These pieces, except one branch of the trigger visible in the figure, are inside the interior of the breech block. Until the breech is completely closed, the trigger is immovable, and premature firing impossible.

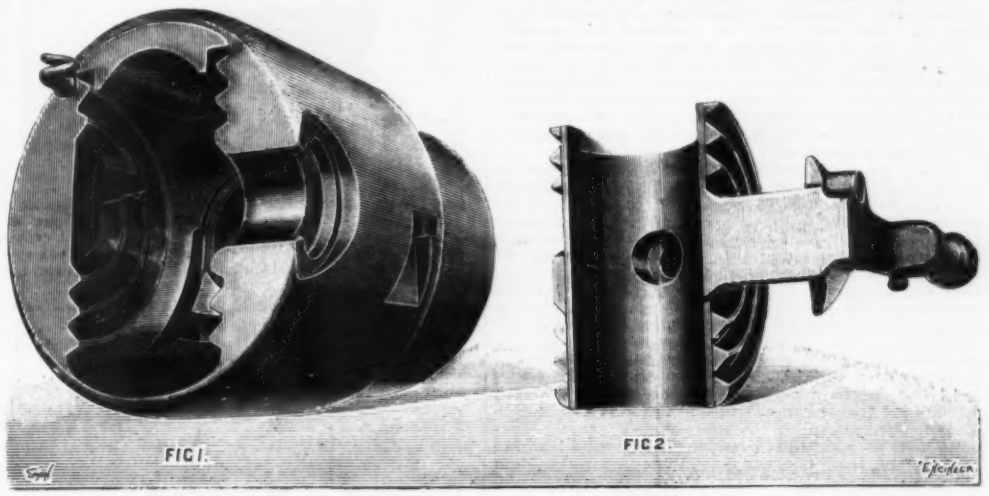
The ejection of the fired cases is effected by an extractor with four branches fixed in the breech of the gun. It is actuated by the breech piece itself, which presses the counter levers at the end of its movement in opening with all its weight.

To open the breech it is enough to touch the handle of the breech piece, to disengage the safety tooth, and then leave it alone. The center of gravity of the breech block is situated beyond its axis of rotation, and the breech opens automatically by its weight alone. This movement is very rapid, for the block only describes an angle of 90° to open the bore completely.

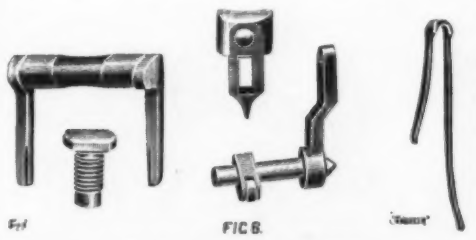
On this movement, the half cylinder takes a position with its diameter horizontal—see Figs. 4 and 5—the hollowed face being in prolongation of the chamber of the gun, and forming a carrier for the entrance of the rear charge in loading. This is a great advantage in rapid firing; it also facilitates the ejection of the fired case by the extractor. To close the breech, it is sufficient to force the lever in the opposite direction until the safety tooth or catch goes home, and secures the breech in its closed position.

Not reckoning the breech block, the mechanism consists of five pieces in all—see Fig. 6. It can be taken to pieces or assembled by hand in an instant. It is sufficient, in fact, to disengage the holding screw, and move the breech block lever through 180°; the block is then entirely free from the gun, and it is easy to replace either an extractor or any other piece.

In conclusion, the important properties of this breech action may be thus summed up: (1) Very swift and easy working by means of a single short lever stroke. (2) Automatic opening without special mechanism. (3) Instant mounting and dismounting by hand. (4) Absolute safety. (5) Absence of all incumbrances in rear of the breech. (6) Complete protection to the working pieces of the breech. (7) Reduction of parts to four in the case of electric firers, five in the case of firing by percussion. Supposing the substance of the breech block to be sufficient to give the necessary strength, the neatness and simplicity of this breech piece must commend itself.—The Engineer.



DETAILS BREECH PIECE REMOVED.



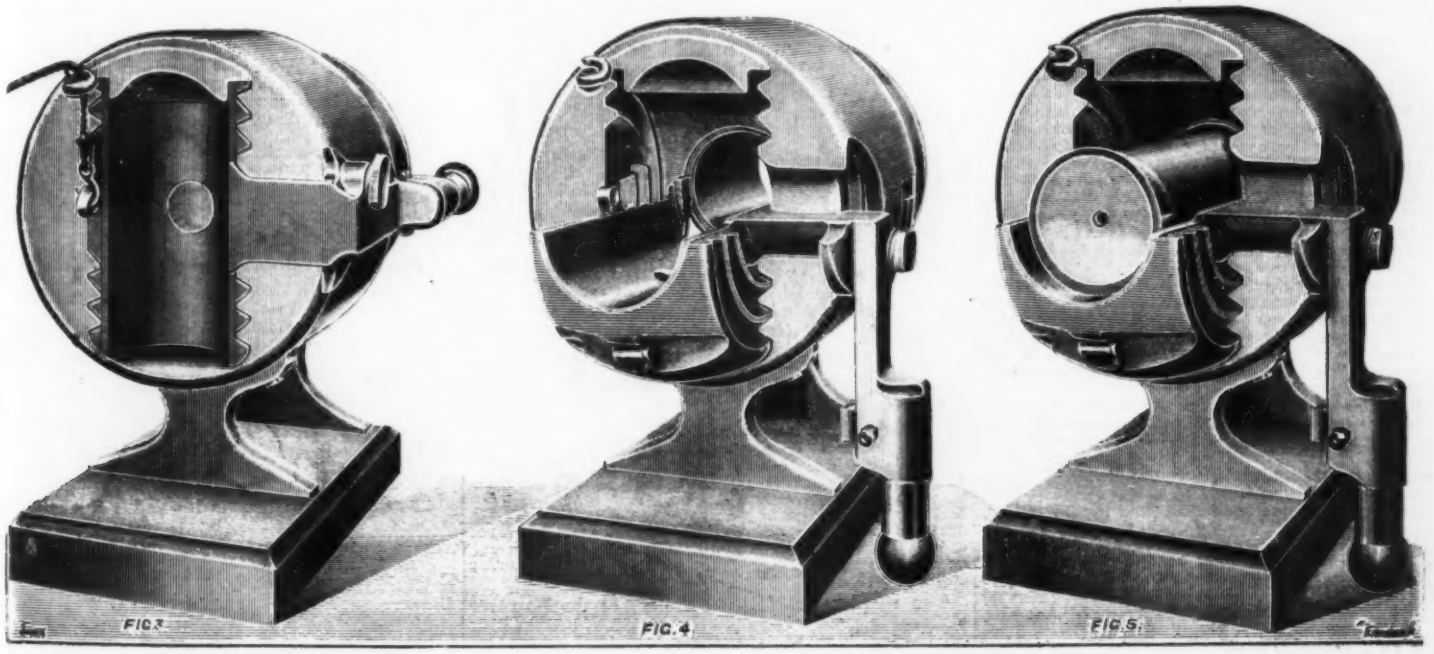
DETAILS OF MECHANISM.

A NOVEL METHOD OF TRAINING.

ACCORDING to the Boston Evening Transcript, Prof. Elmer E. Gates, of Washington, has invented and put into practice a novel method of storing up in the brain of his infant child a vast number of impressions received through each one of the senses, so that the brain will be more fully prepared to receive color impressions in after life than the average artist, more quick to appreciate differences of tone than the ordinary musician, and so on. Whether the results will correspond with the inventor's anticipations time alone can show, but meanwhile his method is interesting. Says The Transcript's correspondent:

"Soon after this baby was born the psychologist began, as the first training, to develop the brain cells controlling his senses of heat and cold. Each day he was placed into a tub of water, whose temperature could be varied to any degree. At first a single bath was given in water having the normal temperature of his body. At the end of six weeks two additional baths were administered, one slightly warmer and the other slightly cooler. The baby was placed first in the cool, then in the normal, and last in the warm water. The limits of the temperatures of the cool and warm water were more exaggerated from week to week by adding more baths, and thus has the infant been trained to endure considerably high and low temperatures by gradual and never sudden changes. A device for developing the acuteness of the child's heat and cold senses is a pair of rubber gloves, connected with both a warm-and-cold-water supply. These are daily rubbed over the entire surface of his little body, while the water inside is made gradually warmer or cooler. As a result of this, the psychologist explained, the baby will be able to endure great differences of temperature, and his brain will be stored with memories of all the degrees of heat and cold which any one is likely to encounter in the course of life.

"At equally regular intervals Baby Gates is made happy by being placed in front of an electric wheel, which revolves pasteboard disks bearing each of the fundamental colors of the solar spectrum. By combining disks any possible variation of color may be shown, with their various tints, shades, hues, lusters, and transparencies. These are produced in the order of the spectrum. The baby watches the wheel closely, and when he is older he will be taught to discriminate between an increasing number of variations. Professor Gates told the writer that the average artist has not seen more than ten or twelve per cent. of these possible variations, and is, therefore, lacking in memory structures corresponding with all of the variations not seen. He lately examined a well-known artist and



CANET'S CONCENTRIC RING BREECH PIECE.

found that he could distinguish less than fifteen per cent. of the combinations shown. Another instrument to be used on the child when he is older is a case containing three large prisms, so arranged that any variation of the spectrum thrown by one can be covered by any part of the spectrum thrown upon the same screen by either or both of the others. Any desired combination of colors may thus be purely made with the original light. By other instruments the effects of colors upon emotions can be measured. Such training, the psychologist believes, is the best possible foundation for an artistic education."

A similar mass of tone sensations is stored up in the baby's brain by means of whistles of different pitches, and the "sense memories" in smell and taste are provided for by an appropriate series of vials, each containing a different chemical, says the Literary Digest. The memories of touch are obtained by handling various substances, "such as sandpaper, velvet, brushes, leaves, grass, earth, glazed surfaces, sticky surfaces, etc." Finally, the muscular sensations are not neglected. Says the correspondent:

"That all of the brain cells governing his muscular sense will be fully developed, this same baby must have every one of the many muscles of his tender body moved systematically and at regular intervals. During this exercise the father keeps before him a manikin showing the position and direction of each muscle. At first the infantile limbs, head, and body were moved in different directions by the father's hands until the memories of the muscular feelings were mentally registered. Now the little fellow is required to stand on the floor and to pick up toys and other objects from various attitudes, which exercise serves as a mild form of gymnastics. No single muscle in the child's entire muscular system is neglected by this action, contrived to combine mental memories of motion, speed and direction in his brain.

"When he is satisfied that the fundamental training is sufficient, Professor Gates will adopt for his child elaborate courses of athletics and manual skill. All of this odd training is combined with play, and is as thoroughly enjoyed as the ordinary romps of children."

THE THIRD RACE OF HORSELESS CARRIAGES.

FROM PARIS TO MARSEILLES AND RETURN.

WE reproduce herewith, from La Nature, views of the horseless carriages that obtained prizes in the recent race from Paris to Marseilles and back, organized by the Automobile Club, of France.

Fifty-two vehicles were entered for the race, but only 32 made an official start fat Versailles. Of these, 27 reached Auxerre; 18, Dijon; 16, Lyons and Avignon; 15, Marseilles; and 14, Avignon, whence they kept on to Paris.

The eight prize carriages are shown in Figs. 1 to 8. To these are added carriage No. 30 (Maison Parisienne), Fig. 9, which accomplished the journey in 108 hours 39 minutes, at a mean speed of 9¼ miles an hour, and carriage No. 26 (Landry and Beyroux), Fig. 10, which made the trip in 119 hours 44 minutes, with a mean speed of 8¼ miles an hour.

The highest average daily speed was reached on the 28th of September, between Avignon and Marseilles, owing to a favorable maestral,* by carriage No. 6 (Fig. 1), which ran at the rate of 19½ miles an hour. The lowest daily speed was that made by the same carriage on the 25th of September, when a fearful storm prevented it from exceeding 13¼ miles an hour. These are performances that do honor to the builders of the carriage, and especially to its drivers, who, for ten days, battled with the elements with an energy and courage worthy of envy.

The Panhard & Levassor carriages are so well known that it is unnecessary for us to dwell at length upon their arrangements. Carriage No. 6 (Fig. 1), which won the first prize, was actuated by a 4 cylinder motor of 8 horse power. Carriage No. 5 (Fig. 3) had an aluminum body and a 6 horse power motor. The ignition was effected through platinum tubes raised to incandescence. The wheels were provided with solid rubber tires.

The Peugeot carriages (Fig. 8) were provided with 4 horse power motors, with two horizontal cylinders arranged in the rear. The ignition was effected through incandescent platinum tubes. The wheels were provided with pneumatic tires.

The Delahaye carriages (Figs. 4 and 6) were actuated by a horizontal motor. The cooling was effected through spiral tubes arranged above the front wheels. The intermediate transmission and change of speed were effected by belts and fixed and idle pulleys. The ignition was electric and was effected through an induction coil supplied by an accumulator. The wheels were provided with Michelin pneumatic tires.

The Maison Parisienne carriages (Figs. 7 and 9) were provided with the Benz motor, arranged in the rear. The distribution was effected through cams and valves. The ignition was electric. The intermediate transmission and change of speed were effected by belts and fixed and idle pulleys.

The Paris-Marseilles-Paris race has unquestionably established the fact that horseless carriages, and tricycles even, are capable of effecting a race of 1,020 miles, in which the stopping places are over 120 miles apart, at a mean speed of 15 miles an hour, or one of 12 or 21 miles, according to unfavorable or favorable meteorological conditions.

After the Paris-Rouen, Paris-Bordeaux-Paris, and Paris-Marseilles-Paris races, is it necessary to begin new tests again in further increasing, if possible, the difficulties and speeds? We think not, and as an epilogue upon this third race, we believe it well to make known the reasons that seem to us more than sufficient for entirely modifying the future programmes of horseless carriage races.

In the first place, the speeds attained are already excessive, and, if it be desired to still further increase them, it is to be feared that the administration, mindful of the grave dangers that may supervene, may put an obstacle in the way thereof by insisting upon an arrangement whereby the speed shall be limited to 18 miles an hour on the level.

It must not be forgotten that the highways belong to everybody, and that horseless carriages cannot be allowed to monopolize them to their profit, by not only crowding them, but running at a speed that would prove dangerous to pedestrians and ordinary vehicles. If these high speeds are reserved for races merely, one cannot occupy himself with them, and the fashion will last for only a short time.

But such speeds have drawbacks that are much graver than mere danger for the future of horseless carriages, since people eventually become familiar with danger, and, time aiding, accept what cannot be prevented. In view of speed, everything else has been sacrificed—comfort, convenience, safety, ornament, and even the most elementary and indispensable arrangements of a vehicle which, by destination, is not called upon to compete with the locomotive. Thus, as regards comfort, the competitors suppressed the hood or kept it constantly lowered. In some of the carriages the hoods were readjusted after the race, in order to avoid carrying a useless dead weight and to prevent

FIG. 1.—CLASS A, FIRST PRIZE (No. 6), MM. PANHARD & LEVASSOR.

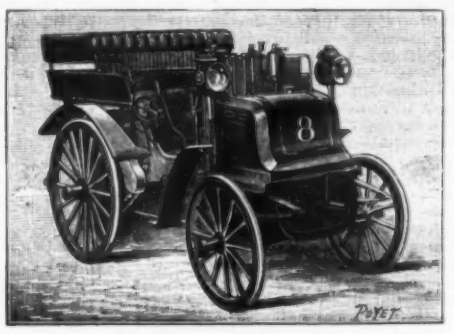


FIG. 2.—CLASS A, SECOND PRIZE (No. 8), MM. PANHARD & LEVASSOR.

FIG. 3.—CLASS A, THIRD PRIZE (No. 5), MM. PANHARD & LEVASSOR.

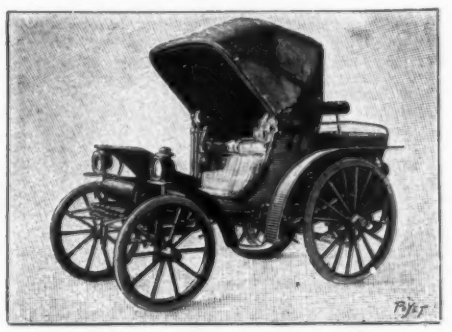


FIG. 4.—CLASS A, FOURTH PRIZE (No. 41), M. DELAHAYE.

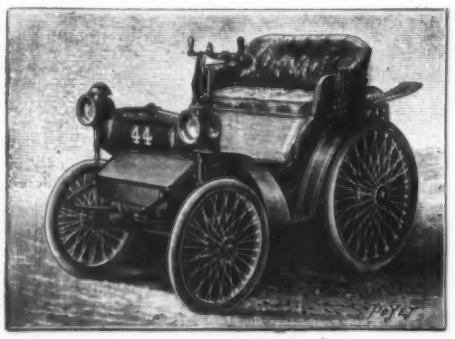


FIG. 5.—CLASS A, FIFTH PRIZE (No. 44), M. PEUGEOT.

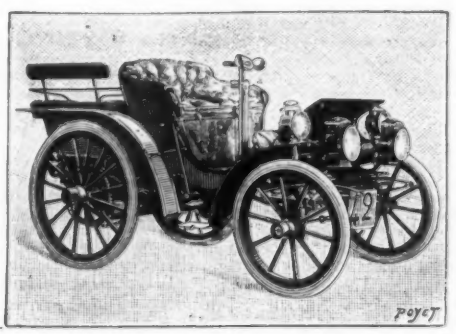


FIG. 6.—CLASS A, SIXTH PRIZE (No. 42), M. DELAHAYE.

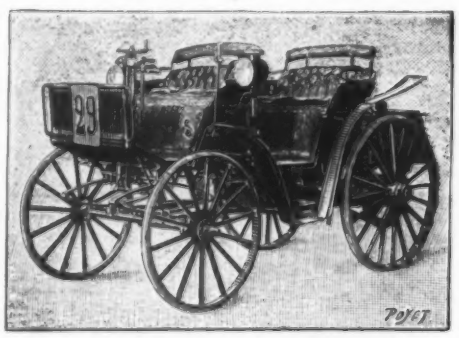


FIG. 7.—CLASS A, SEVENTH PRIZE (No. 29), MAISON PARISIENNE.

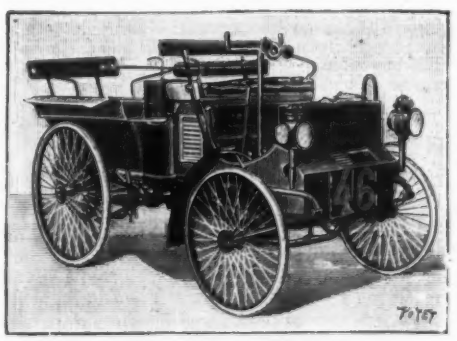


FIG. 8.—CLASS A (SECOND SERIES) SOLE PRIZE (No. 46), M. PEUGEOT.

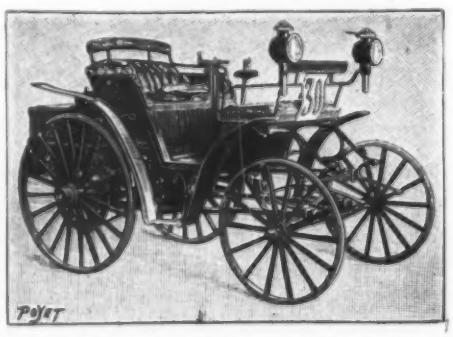


FIG. 9.—CARRIAGE No. 30, MAISON PARISIENNE.

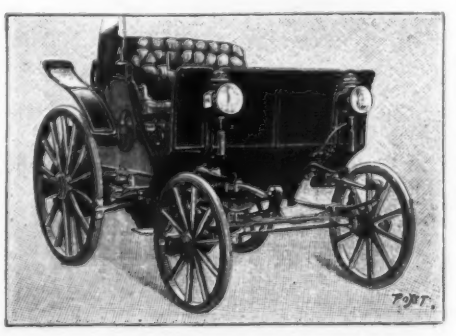


FIG. 10.—CARRIAGE No. 26, MM. LANDRY & BEYROUX.

* Northwest wind in the Mediterranean.

the wind from impeding progress through filling the hood.

The prize carriages were almost all of them provided with solid rubber tires, and a few of them with pneumatic ones. The latter, which give the carriage a peculiarly easy motion, do not as yet withstand excessive speeds when the carriage is somewhat heavy. If it be desired to increase the speed, it therefore becomes necessary to suppress the pneumatic tire, which, nevertheless, perfectly resists a medium speed to the detriment of comfort.

A perfect steering of the carriages at high speeds requires that the load upon the forecarriage shall be heavy enough to prevent any such deviation as might be caused by the smallest stone met with on the route. From this view point, the Panhard & Levassor carriages, whose motor is placed in front, are rationally constructed, but it may prove advantageous, and it is especially agreeable, to have the motor in the rear, from the view point of odors, ease of starting, etc. High speeds, therefore, lead also to a modification of the distribution of the load in an important manner.

High speeds render it obligatory to employ powerful, heavy and cumbersome motors, which require methods of active cooling and large supplies of gasoline, provided that the halting places be wide apart; in a word, there is no longer any space in the carriage except for mechanism. The passengers become a negligible quantity, which is something that should be almost the opposite in a carriage especially combined for traveling and pleasure.

We might multiply examples and furnish numerous arguments in favor of the thesis that endeavors to increase speeds is a step backward in the path of progress and of the practical development of horseless carriages. There should be as much difference between a road bicycle and a racing one as there is between a horseless pleasure carriage and the majority of the horseless racing ones whose successes have been recorded by us during the last three years. Now that the result is known and well known, and that a test of the endurance, strength and speed of the present horseless racing carriages has been made and well made, we would ask whether or not any one is paying attention at present to a tourists' horseless carriage that shall be comfortable and light, and that shall roll upon pneumatic tires and not make over 15 miles an hour.

Such a programme is certainly less sensational than the preceding, but it responds to the needs of practice better, since our tourists are not all hardened like Mr. Levassor, Mr. Archdeacon and tutti quanti, who have led their horseless carriages to victory—or to the precipice!

When will the true race of tourists' horseless carriages, with an appropriate programme, take place?—E. Hospitalier, in La Nature.

To Drill Holes in Glass.—The Bulletin d'Apiculture states that holes can be easily drilled in glass with an ordinary drill, if the spot is moistened with a few drops of a mixture composed of 25 parts of oxalic acid in 12 parts of turpentine. Keep tightly corked.

A NEW MILITARY BOAT.

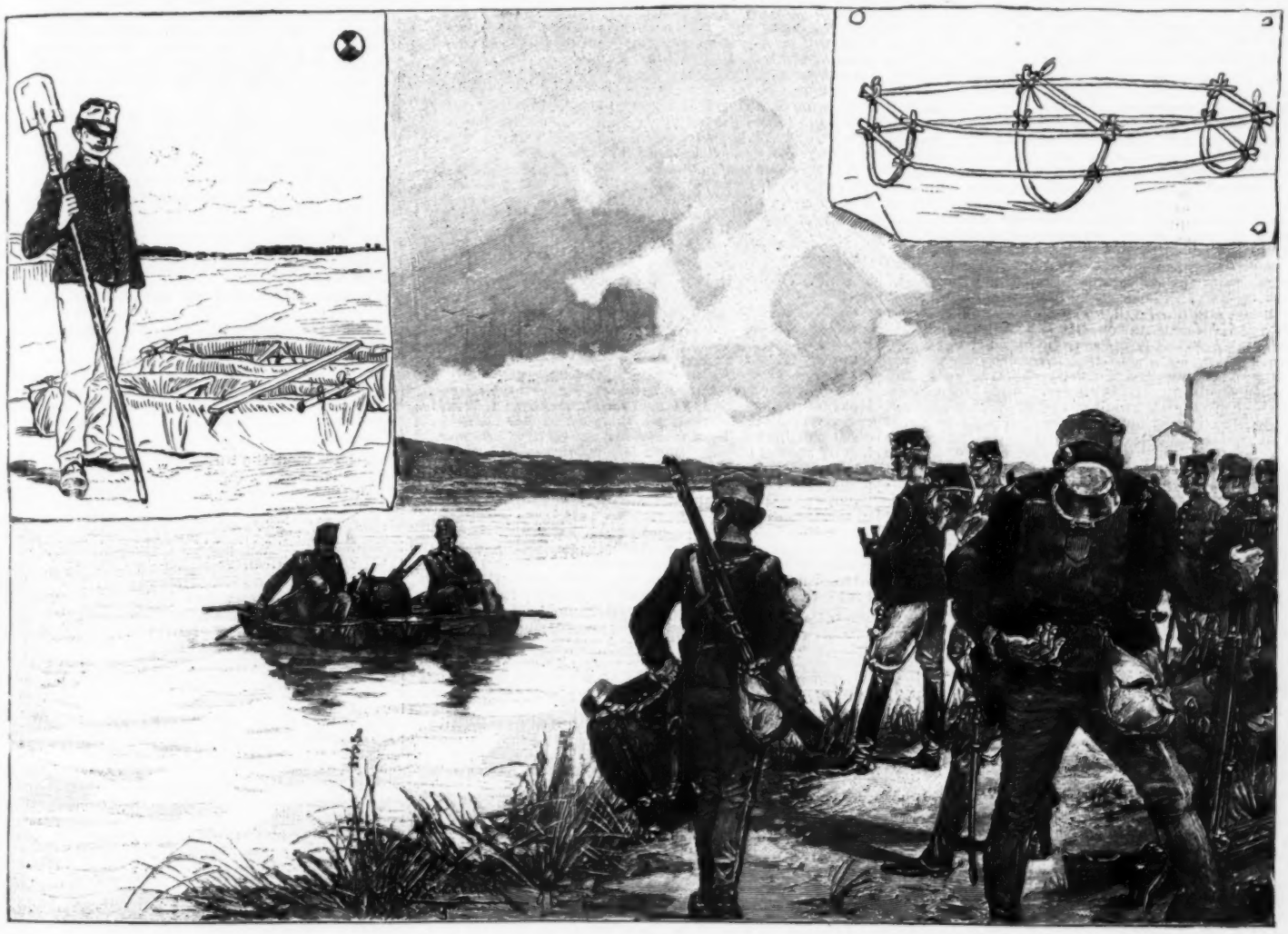
THE establishment of independent divisions of cavalry, and their use in advance of the army during the last two great wars, has rendered it necessary to provide such means of transportation for detachments of this kind that their line of march need not be interrupted by rivers or their course changed, thus incurring waste of time and strength.

In the German and English armies each cavalry regiment is provided with its own folding boats, which consist of wooden frames covered with sail cloth; they can be separated into three parts and are carried on special wagons. In the armies of other countries no such boats have yet been provided; the military authorities have not yet passed beyond the experimental stage, they hesitate to increase the length of the trains by the addition of special wagons, and they hold that small detachments of troops should be able to make use of materials they may find where they happen to halt or material that forms part of their equipment. Thus French and Austrian soldiers have made rafts and bridges of barrels, water-tight food sacks, or sail cloth stuffed with straw and brush; even rubber swimming bags and empty canteens have been used to help soldiers, who could not swim, to cross rivers. Last year, however, the Sixth French Cavalry Brigade was provided with two little folding boats, carried on an ambulance, which were so connected as to make a ferry boat that could be run between the shores by means of a wire cable and a pulley, and for years the Russians have used the basket bodies of peasants' wagons, with the covering that belongs on them, for boats.

Any such means of transportation that can be used by small detachments of troops without great loss of time or outside assistance is worthy of consideration, because such detachments are generally instructed to see without being seen, and consequently are obliged to avoid large bridges and ferries, for these are generally situated in populous districts.

Lieut. Ezerny of the Fifth Infantry Regiment, at Miskolcz, Hungary, has invented a device which may be susceptible of improvement, but which, as now constructed, consists of three light boats made of willow frames over which tent canvas is drawn, that can be connected for use as a ferry boat. For each boat two rectangular frames of the proper size are made, then three willow branches are bowed and tied to these frames, one at the bow, one at the stern and one in the middle, so that one of these frames forms the edge of the boat and the other runs around the boat about half way up its sides. Wherever the parts of the frame cross one another they are tied together. Then the canvas is spread out and the skeleton of the boat, which weighs only about six and a half pounds, is placed on it and the canvas is drawn tightly over the top frame or edge of the boat and secured on the inside to the inner rectangular frame. The boat can then be used, although it will be better to lay a board in its bottom.

At a recent trial in the presence of the commander and many officers, two boats, and later three, were fastened together by means of cross bars and were loaded, first with two and afterward with three men and their equipment, and ferried across the Sajo River, infantry spades with their long handles being used as rudders. A boat capable of carrying 180 to 200 pounds could be set up in twenty-three minutes. After the two boats returned from their first trip, only about two quarts of water had leaked through the canvas.—Illustrirte Zeitung.



CROSSING A RIVER IN BOATS MADE OF TENT CANVAS.

BEVERAGES OF MEXICO.

By ISABEL N. CATLIN.

THE average Mexican does not quench his thirst with soda water or beer. He drinks pulque. And the foreigner with an uneducated stomach wonders how he ever does it.

It is with the feeling of the greatest curiosity that a traveler in Mexico puts the pottery mug of pulque to his lips for the first time. He has heard so much about it: he has heard it condemned fiercely as Mexico's greatest evil. He has heard it praised highly as Nature's best remedy for certain diseases. At every station the train is surrounded by a crowd of natives, all eager to sell their national drink—the men in their bright colored zerapes and beautiful sombreros, the women in sad colored rebosos and bright skirts, the children in very little besides their birthday suits, and every one of them picturesque.

They carry the pulque in jugs of their own manufacture, or in hog skins or sheep skins specially prepared for the purpose. These skins are sold at regular markets for them, and cost the native about twelve "centavos" each. The foreigner who wants to take one home as a curiosity will have to pay ten times that amount. The skins are whole, and it is always a subject of discussion how they are taken from the animal. The Ananias Club is responsible for the following explanation: "The creature is securely tied and then the food is placed just beyond his reach. In his efforts to get to it he finally walks right out of his skin, leaving it whole behind him."

The traveler is easily persuaded to exchange some of his "centavos" for a mug of the pulque, and then he begins to investigate. He sees a bluish white substance about the consistency of buttermilk. The first sip is not satisfactory. He cannot tell just what it tastes like. Trying again and again, he comes to the conclusion that the stuff is very like what a combination of yeast, sour milk, and mucilage would be. Usually he does not finish the first mug, but gives it back to the saleswoman, who laughs heartily at his wry face, and immediately fills up the mug to offer to some other victim. The next time he tries he is able to drink more of it, and after repeated trials he may crave it as a German craves lager, but it is a matter of time and education.

Pulque is made from the sap of the maguey plant, a species of what is called in the North the century plant. Maguey orchards dot the landscape in almost every part of Mexico, but especially about the great city itself for a radius of two hundred miles. The plants are placed in regular rows, from six to eight feet apart, and make straight lines in every direction, as do the cornhills of the Northwest. Soil and location have much to do with the time of maturity of the plant.

which varies from five to fifteen years. Its maturity is its blossoming time—

"But the plant to the flower is a sacrifice,
For it blooms but once, and in blooming dies."

At this time the leaves are about nine feet long, and when allowed to blossom, the flower stock often reaches a height of from thirty to forty feet. The blossoms are not at all pretty, but are a great curiosity in the North, where it does not mature until it is sixty or more years old. The maguey species contains many vegetable elements. Cutting through one of the huge leaves, perhaps twelve inches wide and four inches thick, one finds that the pigment cells which give the rich, copper green color to the external skin occupy a space perhaps half an inch thick, gradually thinning out toward the center of the leaf. This portion of the leaf has an aromatic odor suggestive of bitter resin. In the distilled products of the plant this odor becomes quite pungent, resembling parsley leaves. Outside of this thick, green portion, which is the cutis or true skin of the plant, is a translucent epidermis, very thin and quite tough. When peeled from the leaf in broad sheets it is seen to contain a very minute bird's eye figure, and the general appearance is like mottled parchment. It is said that the ancients used it somewhat as the Egyptians used the papyrus.

Inside the green pigment of the leaf is a white mixture of starch cells and glutinous matter traversed by very tough fibers which run longitudinally through the leaf. These fibers are round, tough and very pliable. Each leaf terminates in a sharp, horny tip, in which the fibers seem to concentrate as muscular fiber concentrates in tendon. When a Mexican peon woman wants needle and thread to patch her failing wardrobe, she cuts around the base of one of these horny tips, about two inches from the point, and, then seizing the horn, she pulls steadily. The tip comes away, bringing with it several of the round fibers from two to eight feet long—and Nature has provided her with a needle already threaded for use.

As the plant shows signs of blossoming it is watched very carefully by the pulque gatherer, and at a certain stage he cuts out the bud and the center leaves, leaving a large bowl-like vessel, in the very heart of the plant. Into this receptacle Nature pours the sap which she had intended for the flower. The gatherer then puts the small end of a large gourd into the sap, puts his lips at the larger end, exhausts the air, and the juice runs up to fill the vacuum. Then the sap is emptied from the gourds into hog skins, and so carried to the "pulquerias," placed in vats made of rawhide, and allowed to continue its process of fermentation, which begins at the very moment that it exudes from the plant. This sap is limpid and mucilaginous, with just enough sugar to invite rapid fermentation. In a few hours minute bubbles of gas begin to appear in every part of the sap, and presently it is changed to a thick, opaque mass of fermentation. There is a faint suggestion of sparkling cider when the biting gas takes hold upon the tongue, but the slimy, clinging streamers of it which trail from cup to lip, and from the lip to the ground, are something of a drawback. A man with a drooping mustache is anything but a pleasing spectacle after a hasty drink of pulque.

Fermentation is so rapid that in a very short time the drink is ready for consumption. The Mexican likes it best when it is about three days old. Prior to that time it is called "pulque dolce," and it is a mild laxative and demulcent of considerable value. Experts are employed to test it and decide when it is just right to put upon the market. Once there, it must be disposed of quickly, or it is a dead loss, for after pulque is from twenty-four to thirty-six hours old it tastes of the putrid animal matter which it has absorbed from the hog skins and rawhide in which it has been, and it is unfit to drink.

The amount of sap gathered from one plant is quite remarkable, often averaging two gallons per day for a period of several weeks. At the end of that time the plant shrivels up and dies, not without having given off innumerable offsets by which the plantation may be renewed.

"By dying it liveth a thousandfold,
In the young that spring from the death of the old."

Pulque is sold everywhere—on the streets, at the stations, in the markets, everywhere where "people most do congregate." A "pulqueria" is a shop where nothing else is sold. In the cities these shops may always be known by the deep fringe of green reeds or rushes which is stretched across the tops of every window and door on the outside. A glance into one of these pulquerias is a novel if not altogether pleasing sight. A counter runs across the shop, not far in from the door. Back of the counter are hog skins, sheep skins, jugs, mugs, bottles, vessels of all descriptions, containing the pulque; in front of it are crowds of Mexicans of both sexes in every degree of intoxication and uncleanliness, buying and drinking. The price is one "centavo" per glass to a native, five "centavos" to a "gringo." This counter is often of the rudest description, with perhaps a soiled piece of white cotton spread over it. The seats, if there are any, are blocks of wood. The floor is of mother earth. The crowd chatters and laughs and evidently makes personal remarks about the visitor who gazes with both curiosity and repugnance at the scene. Should he buy a glass and drink it down with apparent relish, smiles and nods of satisfaction are given him by all present. But should he taste it, make a face and spit it out, or even put his glass down unfinished, scowls and murderous looks are his reward from the back of the counter.

A pulque "jag" is most easily acquired. The first glass will not produce it. It may make one a little sleepy, but that is all. Two glasses begin to get in a little work. And if the drinker have stomach capacity for the third and fourth glasses, he may usually promise himself a "time." Let him take a glass of American beer on top of them, and his friends, if not himself, will wish he had never been born. The two national beverages won't assimilate. And the "jag" is not a clean, wholesome "jag"—if ever there are such. A man drunk on pulque is a most loathsome creature. His thoughts are low, his language foul, obscene. His worst passions are aroused. It is not a "jolly" drunk, neither does he become pathetic and weep over his past, present and future transgressions. He is not exactly maudlin drunk, either. But he is top heavy, thirsty, semi-boisterous, unhappy, ready to fight without the physical ability to fight—a creature to be abhorred and feared.

It is claimed for pulque that, taken in moderation, it has superior medicinal properties. Acid or strongly fermented pulque loses the laxative effect of pulque dolce and becomes a decided diuretic, retaining, however, its demulcent qualities. It is said that Bright's disease, renal calculi, cystitis, and kindred complaints are almost unknown in the districts where pulque is used as a beverage. It is also claimed that the pulque habit is one that is easily acquired, but very hard to eliminate. This is given as one reason why its importation into the United States is strictly prohibited.

Certain localities are said to produce much finer pulque than others, so pulque known to be the production of certain orchards is much sought after by connoisseurs in the line.

"Una centavo por pulque," is the cry one hears on every side from the beggars, whose name is legion in Mexico. Give a beggar boy a coin and he will scamper for the nearest pulque seller, then come back to let you see him drink his mug of it, his eyes shining on you all the while. Beggar women point to the child at the breast and murmur "Centavo, por pulque." As you dismiss your cabman or your boatman, he holds out his hand almost authoritatively, saying, "Centavos, por pulque." The camera fiend sees a picturesque group some place on the road—may be some fishermen going home from their labors. He stops them and arranges them for a "shot." A chorus of "Centavos, por pulque," comes from their throats.

A visitor to Mexico would have to be deaf, dumb and blind who could be in the country twenty-four hours and not be able to understand and pronounce correctly the two words, "centavos" and "pulque."

Fortunately for the beggars, an American usually feels that he is getting rich very fast when he changes his home bills and coins into Mexican money. When he can get $18.50 for a ten dollar bill it is not a bit hard to be generous, and he always feels that he ought to give some of it to the soft-eyed, picturesque beggars.

Not only does the maguey plant give the sap for the drink pulque, but its roots, distilled, yield much more powerful intoxicants, mescal and tequila.

And the heart of another variety of the same plant is cut out, roasted and put through a process of distillation to make still another drink. Mescal is described as tasting like a mixture of gasoline, gin and electricity. Tequila is even worse, and is said to incite murder, riot and revolution. A very small quantity of tequila is a drink. Experts advise it to be taken with a grain of salt, literally—the salt to be placed on the tongue first.

Several Michigan editors who lately visited the sister republic wandered into a "cantina" in the city of Puebla one evening and called for a drink apiece of the tequila. Each took a taste, felt his hair stand erect, his toes curl up and his skin wrinkle all over his body—and was wise enough to leave the glass unfinished. Not one of them wished that time that Providence had endowed him with greater capacity.

All cantinas and pulquerias are closed at sunset, unless by special license, which is very high. It is also a step rate license, being a certain amount up to a specified hour, beyond that hour to a later one more, and from thence to midnight still more. No license is granted to sell beyond the midnight hour in the cities. Regarding this, the government is very strict, realizing that it takes but little of the "budge" to make the naturally bloodthirsty Mexican a revolutionist. But, as in other lands, there are side doors to the "thirst parlors," and it is usually more economical to cut one through than it is to pay the government license. The Michigan editors referred to suspected the side door, but didn't know how to get to it. After consultation, they invoked the aid of a policeman, who very kindly showed them the way. Fancy an American policeman towing a party around to the back door of a saloon after closing hours!

Mescal is distilled by the crudest of methods. Hand stills are very common throughout the country, and the natives get gloriously drunk on home production, and at very little expense. In the regular shops mescal and tequila sell for about three centavos a drink.

The most expensive of all the Mexican drinks is aguardiente, a strong brandy distilled from fruits. Very little of it is used by the natives on account of its cost. It may be procured at all of the first class places, and is said to be very palatable.—Pharmaceutical Era.

THE LEAN MEAT DIET.

THE diet of lean meat, so often prescribed for dyspepties and others, is not in favor with the editors of Medical Progress, who say concerning it: "The truth seems to be that a person subsisting upon a lean meat diet, while he may manifest a greater amount of strength than upon more natural dietary, and may be unconscious of any abnormal condition, is like a person in a powder magazine—he is in constant danger of vital catastrophe. The poison-destroying functions of his liver and the poison-eliminating capacity of his kidneys are taxed to their utmost to keep the proportion of ptomains and leucomains in the tissues down to a point which permits of the performance of the vital functions. The margin of safety, which nature has wisely made very large in order to provide for emergencies, is reduced to the narrowest possible limit, so that anything which temporarily interferes with the functions of the liver or the kidneys, or which imposes additional work upon them, may be sufficient to obliterate the safety margin, and produce an attack of grave or fatal disease. Invasion of the body by ptomain-producing microbes, such as the typhoid bacillus, the bacillus of diphtheria, the pneumococcus of Friedlander, the shocks resulting from accident, and even the depression of a severe cold, may be sufficient to consume the meager emergency capital, and the result is acute inflammation of the kidneys, or death under chloroform or from shock following an operation under anæsthesia."

It is said that runaway horses are almost unknown in Russia. No one drives there without having a thin cord with a running noose around the neck of the animal. When the horse bolts, the cord is pulled, and the horse stops as soon as it feels the pressure on its windpipe.

SELECTED FORMULÆ.

Shoemaker's Ink.—One part of the handwork to which great importance is attached at the present day is the inking, says the Boston Journal of Commerce. But it is not always easy to have good ink, but a good recipe is given below that will impart a beautiful black color. The ink used in shoemaking is made of two parts of gall nuts and one part of Senegal gum and twenty parts water. This makes a first class ink. If common gum is used it is sometimes necessary to double or triple the dose; with some kinds of gall nuts, to quadruple even to obtain as good results as with the Aleppo galls. After the ink is made it should be left in the open air for nine months, to obtain a deep color by the action of the oxygen, and to let the particles precipitate that will not dissolve. Ink that is not treated in this manner is not black enough and needs to be put on several times to overcome the coloring matter of sole leather, especially when it is smooth. It is impossible with muddy ink to do good work. The shoemaker who uses good ink for his work saves time and obtains a beautiful color without trouble. What is especially recommended is not to imitate those who use iron rust in the water (oxide of iron) to make ink. This rust becomes muddy under the iron and burns the fibers of the surface of the leather and cannot become brilliant. According to the proportion of the ingredients, more or less ink can be made. The recipe given interests both the small shoemaker and the big manufacturer who uses great quantities of ink.

Lubricant for Stamp Stems.—Common bar soap is recommended as an excellent lubricant for the stems of stamps in steam stamp mills. Unlike anything of a greasy nature, soap does not interfere with the amalgamating, but, on the contrary, mixing with the water dripping from the stuffing boxes and the water in the mortar, it has a cleaning action on the amalgamating plates, removing all verdigris which otherwise might accumulate, and improves the working of the mill.—Colliery Engineer.

Strontium Tooth Paste.—Metral, of the Geneva Dental College, has studied strontium carbonate as a dentifrice, and recommends the pure precipitated carbonate. It is a smooth white powder, lightly alkaline, tasteless and inodorous. Its detersive power is between that of chalk and pumice. Metral suggests the following as a satisfactory paste:

Strontium carbonate	90	grains
Sulphur precipit	45	"
Powder soap	½	ounce
Rose essence	6	drops
Mucilage acacia and glycerin, of each	q. s.	M.

—Canadian Pharmaceutical Journal.

Russet Leather Polish.—

Liquid annatto	2 drachms
Boiling water	7 ounces
Castile soap	4 drachms
Beeswax	2 ounces
Turpentine	5 "

Melt the wax in the turpentine; dissolve the soap in the water with the annatto, then pour gradually into the melted turpentine and wax, stirring until quite cold.—Pharmaceutical Era.

Falling Hair.—

(1)

Tincture bloodroot and tincture of cantharides, of each	½ ounce
Glycerin and castor oil, of each	1 "
Powdered carbonate of ammonium	1 drachm
Alcohol	12 ounces
Bay rum	4 "
Extract heliotrope	2 drachms
Oil bitter almonds	5 drops
Oil rose geranium	1 drachm

Add the oils to the alcohol; dissolve the carbonate of ammonium in the bay rum, and add the glycerin, then unite the two mixtures and shake well together. Apply every two or three days.

(2)

Tincture of cantharides and Jamaica rum, of each	2½ ounces
Glycerin	1 "
Spirit of ammonia	2 drachms
Oil of nutmeg	½ "
Distilled water	9 ounces

—Pharmaceutical Era.

Preparation of Wash Blue in Cakes.—These may be made from various grades of ultramarine blue, namely, 40 p. of best ultramarine, 20 p. of second grade, with 40 p. of sodium bicarbonate and 12 p. of liquid glucose: this makes a bluing of the best quality. A second quality contains 50 p. of ultramarine (2d grade), 50 p. of sodium bicarbonate and 12 p. of glucose. A third quality contains 20 p. of ultramarine, 80 p. of sodium bicarbonate and 12 p. of glucose. A very cheap grade is made up of 20 p. of ultramarine (2d grade), 20 p. of dry blue earth, 15 p. of kaolin, 15 p. of sodium bicarbonate and 12 of glucose. The glucose is diluted with water to 16° Baumé density before mixing. The materials should be finely ground and well mixed before moulding into cakes, then sprinkled over with the best grade of ultramarine. To harden the cakes, an addition of acacia, gelatine or dextrine to the glucose solution is necessary. The cakes may be inclosed in linen envelopes.

Soap Liniment that will not Solidify.—The formula for the soap to be used is as follows:

Oleic acid	1,000 gr.
Caustic soda	60 "
Water	2 oz.

Dissolve the soda in water and mix gradually, with constant stirring, heat moderately, and when saponification is complete set aside to cool. This forms a hard soap, and if poured into frames can be made into bars. If it is desired exactly neutral the alkali must be added gradually, and only enough added so that a little of the soap dissolved in alcohol and a few drops of solution of phenolphthalein added, the color should remain a very light pink. This is not much more trouble to make than the first, and is much better, especially for making oleates.—Canadian Pharmaceutical Journal.

ENGINEERING NOTES.

A new armor steel has been invented by Samuel Maxim, the brother of Hiram Maxim, of machine gun fame. Mr. Maxim, according to the Philadelphia Record, claims to have simplified the process of manufacturing the famed Wootz steel of India, still made by laborious crucible methods in that country. He submits specimens which are said to cut glass with ease and says he can, by his process, much increase the resistance of armor plate while greatly reducing the thickness and weight.

The Belfast News Letter has recently published two articles on the advantage of a channel tunnel between Ireland and Scotland. The subject is not a new one, but the writer thinks the present seems, for a number of reasons, to be an appropriate time for recalling public attention to it. At a public meeting held in Belfast city some years ago, a proposal was made for the construction of a tunnel between the Antrim coast and the Mull of Galloway, the intention being to connect the railway at Stranmaer with the lines which have their termini in Belfast. One of the most obvious advantages of the tunnel would be the great acceleration of the passenger and mail service which it would make possible. It takes at present 13 or 13½ hours, by the most rapid of the existing services, to go from Belfast to London. According to calculations made by the writer of the article, this time could be reduced to 10½ hours. Glasgow could be reached from Belfast in 4 hours, Edinburgh in 5, York in 7, and so with other cities and towns.

On the question of fenders the president of the New York State Street Railway Convention said the other day: "The question of fenders is still confronting us, and is a most perplexing problem. More patents for street car fenders have been granted during the past few years than for any other class of inventions. It is stated upon good authority that there are upward of 4,000 on the market. It is the opinion of many street railway men that the fender is a menace. Your executive committee were anxious that an act be passed regarding fenders. There were a number introduced. The one introduced by the chairman of the Assembly railway committee seemed to meet the approval of the public and was heartily indorsed by your executive committee, but for some reason it never became a law. The street railways are anxious that the State should share some of the responsibility. I stated last year, and still believe, that the best fender for the front end of a car is a clear headed motorman."

Among the schemes for public works engaging the attention of the Russian government is one for the connection of the Baltic and the Black Sea by a waterway along the Dwina, Berezina, and Dnieper, to Kherson. The British consul-general at Odessa, in his last report, discussed this project, and observes that if it were carried out it would throw into the shade all other works ever undertaken in Russia, including the Siberian railway. It would do more to develop the coasting trade of Russia than any other enterprise, and in the event of war would enable Russia to transfer her whole fleet from the Baltic to the Black Sea, or vice versa. But those conversant with the actual conditions under which the scheme would have to be carried out are of opinion that the difficulties in the way are much underestimated. The greatest of these is that rivers which would have to be used contain little water at some seasons of the year and at others swell to a surprising degree. The rapids on the Dnieper are said to present almost insurmountable obstacles to navigation, and the amount of labor entailed in constructing a canal navigable both ways would be enormous at this point alone, while it would be impracticable to cope with the immense volume of water that sweeps over these rapids during the spring floods. The only alternative would seem to be the construction of a canal with a system of locks to run parallel with the river past the rapids. This, too, is impracticable, for the cost of constructing such a waterway of adequate depth would be fabulous. "To embark on an undertaking so difficult to accomplish seems all the more surprising when we come to consider that the Volga and Don are waiting to be connected at Tsaritzin, where the distance is comparatively small, the railway between these two points measuring about 50 miles. This canal would link together the Black Sea and the Caspian, and would be invaluable to traffic."

The mountain railway between Beyroot and Damascus across the Lebanon and the Anti-Lebanon has now been completed, having been under construction five years, says The Engineer. It was commenced in 1891 by the then constituted Compagnie Ottomane des Chemins de Fer Economiques en Syrie. The engineering difficulties have been very considerable. The line rises on the western slope of the Lebanon to a height of 1,487 meters in a distance of 37 kiloms., the average incline being 1 in 22·5. Here the cogwheel system has been adopted for the greater part of the line, the incline being 1 in 14·3, with short sections of adhesion railway with an incline of 1 in 40. On the eastern slope there are also cogwheel sections, but in crossing the Anti-Lebanon this system has been avoided by a detour to the north. The entire length of railway is 146·6 kiloms., of which 105 kiloms. are cogwheel railway. The gage is 105 centimeters, and the minimum radius 100 centimeters on the adhesion and 120 centimeters on the cogwheel railway. The gage of 105 centimeters was selected in regard to the already completed railway Damascus-Bindschick. The rails weigh 27·6 kilos. per meter, and rest on iron sleepers, to which even the cogwheel track is fixed. The system is the Aptor, the same as on the Snowdon Railway. At intervals of 50 meters to 100 meters, great blocks of concrete have been sunk in the cogwheel track, to which the superstructure has been fixed. The locomotives are of two kinds, one for cogwheel and one for adhesion railway, both constructed at the well known Winterthur Works in Switzerland. The ordinary engines are six-coupled tank locomotives, weighing 40 tons, having a hauling capacity of 5 tons. The cogwheel engines are like the former, but weigh 44 tons, and are capable of hauling 10 tons. The trains are fitted with vacuum and compressed air brakes. The average speed on the ordinary track is 35 kiloms. and on the cogwheel track 10 kiloms. an hour.

ELECTRICAL NOTES.

It is reported that the Lookout Mountain Railroad Company, controlling what is known as the broad gage line to the top of Lookout Mountain, in the suburbs, will substitute the trolley system for steam on its road.

The bicycle railway which was intended to connect the G. T. R. station, at Ridgeway, Ont., with Crystal Beach, has proved a failure through inadequate construction and unfortunate designing, says the Canadian Engineer. The cars were to run on a single elevated rail, the balance being obtained by flangers and twin wheel guards and weights on either side beneath the level of the rail. The operating power was electricity.

A curious defect has been discovered in Buda-Pesth's underground railway, says The Engineer. There are not enough ventilating apertures in the tunnel, and the trains rushing through it compress the air in it like that in the tube of a Zalinski pneumatic gun. On some occasions the cars are said to have been lifted from the track and the passengers almost suffocated. One stretch of tunnel, two miles long, has only a single ventilating aperture, making it almost an airtight apartment.

Some interesting statistics showing the rapid development of electric tramways during the year 1895 are given in the Journal des Transports, the number of lines in working order having increased from 70 to 111, while the total length of lines has gone up from 437½ miles to 564. Germany heads the list with a total length of 255 miles and 857 motor cars, France being second with 82½ miles and 223 vehicles, while England is third with 67 miles and 168 cars, Switzerland coming fourth with 29½ miles and 86 cars. Bulgaria and Denmark are the only countries which have no line with electric traction. Of the 111 lines now being worked, 91 are driven by wires overhead, while 9 have a central rail, 8 accumulators, and 3 an underground current.

The three electric locomotives of the Baltimore and Ohio Railroad tunnel line, at Baltimore, O., will soon be used to handle the passenger trains as well as the freight trains, according to the Railroad Gazette. The overhead conductors are being extended three-quarters of a mile northward—to the new Mount Royal Station—and 1,500 feet southward to obviate the necessity of using steam "pusher" engines on the tunnel approaches. The electric engines are giving good satisfaction, and the maximum load hauled so far has been a train of 41 loaded freight cars with two locomotives not working. The electric power plant is now being used not only to furnish the power for the tunnel locomotives but to run 180 street cars of the Baltimore Traction Company, and also to furnish a large amount of light.

Aluminum is used to conduct electricity in the new aluminum works of the Pittsburg Reduction Company at Niagara Falls, transmitting current from the generators in the power house to the electric furnaces in the melting house. The electric conductivity of aluminum, according to M. Lazare Weiler's table, is 54·2, pure copper being 100. The specific gravity of aluminum is 2·67, and that of copper 8·85, or 3·32 times as much. To carry the same current as could be carried by a rod of copper of 1 square inch section would require $1 \div 0{\cdot}542 = 1{\cdot}845$ square inch of aluminum, and this would weigh only $1{\cdot}845 \div 3{\cdot}32 = 0{\cdot}556$ of the weight of the copper. If the cost per pound of aluminum were only 1·8 times as much as the cost per pound of copper, then the cost of a conductor of each of the metals would be the same.

A comparison of the use of gas, petroleum and electricity in Germany is given in a report received at the Department of State from Consul-General Frank H. Mason, stationed at Frankfort. From official statistics it appears that the consumption of gas in Germany during the year 1895 aggregated 25,884,900,900 cubic feet, for the production of which 2,750,000 tons of coal were used. The number of gas lights in use was 5,734,672, the number of gas motors 15,644, aggregating 52,000 horse power, while the 180 electrical lighting plants in the empire supplied 950,000 lights of an average power of sixteen candles each. All the more important gas companies showed a marked increase in product. On the other hand, the increased consumption of petroleum has been not less marked and steady during the same period. The importation of petroleum increased from 4,628,696 barrels in 1891 to 5,677,406 barrels in 1895. American oil completely dominates the market and to all appearances will continue to do so, notwithstanding the effort of both Germany and Russia to increase the importation of the Russian product. Mr. Mason also speaks of the efficiency of gas motors.

During the past summer a number of deadly lightning strokes have seemed to be beckoned to their fatal work by some small bit of metal in the hand, or the pocket, or elsewhere on the person of the victim, says The Independent. It is thought that the two young men who were killed while playing golf near Utica drew the stroke upon themselves, by metal tipped golf sticks, and there are instances on record of persons who, after a shock, have been found with all textile parts of their garments intact, and all metallic hooks, clasps and buttons melted, together with knives, glove fasteners, cigar cutters, etc. As to the large number of persons who still continue to take refuge under trees and lose their lives by so doing, one has to say, they are hopeless illustrations of the inability to be warned by example, for the journals of the day have so many cases of the sort that, if we did not know of the constant repetition of these instances, we should say it is not possible for people to act so foolishly. A late item in the College and Clinical Record says: "A curious fact connected with deaths by lightning has recently been noticed in Europe. It appears that as compared with the country, towns, and especially cities, possess remarkable immunity from lightning stroke. Between 1800 and 1851 there was not a single death by lightning recorded in Paris, and only one person out of each million who die in London lose their lives through Nature's electric battery. Between 1851 and 1895 only three persons were struck in Paris, and only one of these died. In Berlin only five persons have been struck by lightning since 1713." It is thought that the even distribution of metals in pipes may account for the immunity of cities.

MISCELLANEOUS NOTES.

Some experimenter in Germany has discovered that India rubber can be made very hard by mixing it, before it is vulcanized, with powdered aluminum. It is said that articles made from rubber that is hardened in this manner are exceedingly durable.

According to an Italian statistician homicides are most frequent in Sicily (29·36 for every 100,000 inhabitants), and after Sicily are Calabria (25·97), Sardinia (25·07), and Campania (23·86). In northern and in one part of central Italy homicides are much fewer, sinking in Lombardy to 3·22, in Venetia to 3·41, in Piedmont to 5·95, and in Tuscany to 6·78.

The average daily supply of water to London delivered from the Thames during the month of September was 111,228,831 gallons; from the Lee, 44,812,539 gallons; from springs and wells, 33,833,274 gallons; from ponds at Hampstead and Highgate, 130,673 gallons. The daily total was, therefore, 190,005,317 gallons for a population estimated at 5,634,449, representing a daily consumption per head of 33·72 gallons for all purposes.

Paving blocks made of meadow grass are now being made in Atlantic City. The inventor is Rev. J. H. Amies, and the meadow grass impregnated with oil, tar and resin, is pressed into blocks measuring 14 in. by 21 in. by 6 in., and then bound with iron straps. These blocks are said to weigh 40 lb. per cubic foot, and can be made denser if desired. The claim is made that the street pavement of these blocks is noiseless and elastic, resists wear well, and is impervious to heat and cold. Its manufacturers guarantee its life for five years. A plant was erected in Norfolk, Va., about three years ago, and experiments were made with the pavement in Norfolk and Richmond, and the results are claimed to have been very successful. The grass used is the ordinary wiry salt meadow grass, common along the Atlantic coast.

Commissioner of Labor Carroll D. Wright's statistical bulletin concerning convict labor in the United States shows that the total number of convicts in penal institutions in the various States in 1885 was 41,887; in 1895, 54,244. In 1885 the number engaged in productive labor was 30,853—73·7 per cent. of the total number; in 1895 the number engaged in productive labor was 38,415, or 70·8 per cent. The total value of goods produced or work done in the United States for the various States and Territories in all the State prisons and penitentiaries for 1895 was $19,042,472. In 1885 the total wages paid by contractors and lessees for the labor of convicts, from which resulted a product of the value of $28,753,993, was $3,512,970, or $1 of convict labor wages to $8.19 of finished product of convict labor. At the present time, in all probability, the total value of the labor expended by the convicts in the State penitentiaries and prisons of the country is about $2,500,000.

A high value has often been set upon jewelry and other articles of vertu, their appreciation being derived not so much from intrinsic worth as from considerations of rarity or of historic interest. There is now to be seen, however, at the establishment of a jeweler in the Strand, London, a costly watch whose actual value has been estimated at no less than $11,000. While not larger than an ordinary watch, it is at once a minute chronograph and repeater, exhibits the phases of the moon, and is also a perpetual calendar, which by an ingenious arrangement marks at its proper time the recurrence of leap year. On each side of its fine gold case are a number of first water diamonds weighing 26 carats. The dome of the watch is decorated in colored enamel, representing a horse with his jockey. Scarcely less remarkable is the magnificent fob which accompanies the watch. This is delicately worked, in fine gold, and represents the various portions of the housing and harness of a racehorse—horseshoes, whip, curb chains, bit, etc.—the whole weighing 7 oz.

E. H. Farrington finds that the presence of boric acid in milk increases the acidity of that fluid in a curious manner. On dissolving 0·5 gm. of boric acid in 500 c. c. of water, it was found that 20 c. c. of the resulting solution required 1 c. c. of one-tenth normal alkali to produce a pink color with phenolphthalein. When the acid was dissolved in milk, however, in the same proportion, 20 c. c. required the addition of 8 c. c. of the same alkaline solution to produce the pink color. The water was neutral before the addition of acid, while 20 c. c. of the plain milk gave the pink color with 4 c. c. of the one-tenth normal alkali. In other words, the same amount of boric acid increased the acidity of a given sample of milk four times as much as it did the acidity of the water. No explanation of this fact is offered by the author, but he points out that a simple means is thus afforded of detecting boric acid in milk. The acidity of the prepared milk examined represented 0·36 per cent. of lactic acid, and it is considered that milk which apparently contains over three-tenths per cent. of lactic acid, and yet neither tastes nor smells sour, may safely be regarded as adulterated with some preservative, probably boric acid.—Journ. Am. Chem. Soc.

Indurite is the name given to a smokeless powder invented by Dr. Monroe, of the American Chemical Society, made by purifying dried military gun cotton, by extracting it with hot methyl alcohol in a continuous extractor. When this is completed, the insoluble, nitrated cellulose is again exposed in the drying room. The highly nitrated cellulose is then mixed with a quantity of mononitro benzene, which scarcely affects its appearance, and does not alter its powdered form. The powder is next incorporated in a grinder, by which it is colloidized and converted into a dark translucent sheet or mass resembling India rubber. The sheet is now stripped off, and cut up into flat grains or strips, or is pressed through a spaghetti machine and formed into cords, either solid or perforated, of the desired dimensions, which are cut into grains. Then the granulated explosive is immersed in water boiling under the atmospheric pressure, by which the nitro-benzene is carried off, and the cellulose nitrate indurated, so that the mass becomes of light gray to yellow color, and as dense and hard as ivory. It is by this physical change in state, which can be varied within limits, that the material is modified from a violent rupturing explosive to a slow burning propellant.

FORECASTING FAMINES IN INDIA.

By DOUGLAS ARCHIBALD.

THE scarcity which is now developing into famine in India, caused by an unusually early withdrawal of the monsoon, draws attention to the possibility of forecasting such events.

The crucial test and ultimate aim of every true science is accurate prediction.

In physical problems, when all the antecedent causes and operative laws are known, it is usually easy to predict the result. Where, however, as in meteorology, both the causes and the laws are only partially known, and where the intrusion of unforeseen factors and combinations may occur both in time and space, prediction must at present be based more or less on empirical relations and analogy. If carried beyond the time limits of direct observation, it must be of a broad and general character, in direct proportion to the time covered by the forecast.

So far, in England, and in most European countries, weather prediction has never advanced beyond the twenty-four hour limit, and is based almost entirely on an examination of contemporaneous data and empirical relations founded on past experience, together with a modicum of rational law. In America, owing to the wide area traversed by ephemeral weather changes, the time limit is extended to thirty-six hours, and in Australia disturbances reaching Western Australia are forecasted to arrive in Victoria about three or four days after, but this is the extreme limit.

It is beginning at the wrong end to predict the particular, but so long as the method is confined to what is taking place within the area of observation, though the deductions are made on empirical bases, they can hardly fail to reach a certain percentage of accuracy, sufficient for practical purposes.

When we extend the time limit to several months instead of hours, and, ignoring the minor fluctuations, take note merely of the general average prevalent character of the weather during the whole period, a marked departure has to be made in the system employed.

Monthly averages take the place of hourly means; contrasts and analogies between the conditions for six monthly periods preceding and embracing the monsoon periods have to be studied. The area of observation also has to be extended beyond the limits of the district dealt with, in order to determine the subsequent effects of ascertained general conditions prevailing in surrounding areas.

On such principles the Indian six monthly forecast has been founded, and its success has been sufficient to induce the Indian government not merely to grant the funds necessary to establish fresh observations in the Persian area, but also to arrange for the transmission of cablegrams from Mauritius. By these means, the conditions which prevail in the South Indian Ocean may be reported to the office at Simla in time to be utilized for the forecast.

Although within certain limits, the summer monsoon —which bursts, after being ushered in by heavy thunderstorms, about June 6 in Bombay, and arrives at its northernmost limits some two or three weeks later— is a tolerably regular phenomenon; it is not nearly so regular both in time and quality as is commonly supposed. Its date of arrival, for example, occasionally varies as much as thirty days, while the amount of its attendant rainfall has varied from a deficiency of six inches in 1868 to a surplus of nine inches in 1893. Concentrated in one spot, this latter excess would equal two hundred and eleven cubic miles of water. To give an idea of what such an amount really means, let us suppose the excess rainfall of 1893 to be collected in a tank with a square base of eight miles a side. Then if its altitude were that of the snow line of the Himalaya, viz., seventeen thousand feet, such a tank would barely contain the total volume of excess water which fell over India during that year. Similarly, if in order to supply the defect in 1868 we imagine a hose pipe to stretch all the way from the earth to the moon, of half an acre in section and full of water, it would represent a trifle more than the above defect. If it were required to irrigate the country with this hose, in order to keep up the supply to the normal during the six months of the monsoon, the water would have to issue from the hose at the rate of fifty-five miles per hour continuously.

Moreover, although such variations, spread over the entire area, reach this gigantic amount, their local effect is relatively much greater, and produces much more disastrous effects in the dry zone inland than near the coast, where the rainfall is normally high. In this zone, which comprises the Deccan, Mysore, South Madras, Central and South Punjab, and the western section of the Northwest Provinces, variations often occur amounting to several hundred per cent. of the normal supply. It is this district which, as at present, is most liable to famine producing droughts or floods.

The method of long period prediction began some years back under the late Mr. Blanford, F.R.S., by the recognition of certain sequences which were observed to occur in the summer monsoon rains, according as the snowfall of the preceding winter on the Himalayan slopes was heavy or otherwise. A heavy winter snowfall was usually found to be followed by a light summer monsoon rainfall, and vice versa.

Although this factor has latterly been found to be liable to some uncertainty and modification, owing to variations in the absolute strength, quality, and duration of the monsoon current itself, it still forms one of the leading principles by which the extension of the current to its full northerly limits is predicted.

Heavy and untimely snowfall, especially in April or May, exercises a powerful influence in preventing or delaying the extension of the monsoon over Upper India.

Another factor is afforded by the local peculiarities which are manifest in the hot weather period immediately preceding the arrival of the monsoon, and which are best estimated by means of the synoptic variations of the current barometric pressure from the normal.

At one time it was thought that these local anomalies of pressure were the chief cause of the monsoon itself, on the principle of the sea breeze toward a heated area. This was formerly alluded to as the "furnace theory." It is now, however, clearly recognized that the advance of the massive current itself is not directly the result of the hot weather over the Indian area, but that it forms part of a larger system of circulation. Its forward extension across the Equator is as much due to a vis a tergo, effected in the South Indian Ocean, as to a vis ad frontem, in consequence of changes over the Indian land area following the northward march of the sun. As soon, however, as the current is once established over India, it is found that it tends to concentrate its rainfall energy mostly over those districts where the pressure was lowest during the antemonsoon months.

Hence this second factor is of great service in determining the local or provincial variations of rainfall, though, like the snowfall factor, the deductions have to be modified in correspondence with the precise character of the incoming current.

The last factor is the condition of the southeast trade wind of the South Indian Ocean, which is now found to be nothing else than the direct parent of the monsoon.

The modus operandi by which the southern trade wind crosses the Equator in May and rushes across the Indian Ocean as the southwest monsoon, which breaks on the Indian coasts early in June, has been graphically described by Mr. Eliot in a recent paper in the Quarterly Journal of the Royal Meteorological Society (January, 1896). We need not here allude to it further than to say that while a feeble sea breeze develops along the Indian coasts for some time previous to the monsoon burst, the latter is evidently in no sense its culminating stage. On the contrary, as Mr. Eliot substantially puts it, it is plainly due to the breakdown of the upflow over the equatorial calm belt, which allows the southeast trade wind to continue its horizontal flow across the Equator. It thus brings the vapor accumulated during its southern journey in a massive sheet, which condenses when carried up the Indian ranges and plateaux.

The only direct means of estimating the probable strength and character of this vapor current is to ascertain the character of the southeast trade wind of the Indian Ocean, south of the Equator, during April and May. It is found that this is usually maintained comparatively unaltered for some months, and is transmitted, pari gradu, to its defluent extension, known as the southwest monsoon of India.

Up to the present time the information has usually been derived either from the logs of ships arriving at the Indian ports from the southern seas or else by letter from Mauritius, the Seychelles, etc. Latterly, however, the Indian government has sanctioned the establishment of cable communication to the Seychelles, and is preparing to do everything in its power to accelerate the transmission of news from the Mauritius, Zanzibar, etc.

Meanwhile, as a supplement to the direct observation of the trade current, it has been found that the monthly average barometric pressure over India is subject to periodic, long oscillations, above and below the mean. These vary from six to twenty-four months, and are usually some multiple of six months.

These waves of pressure are found to be connected with the development of the monsoon current in such a way that if the wave is rising during the month or two (April and May) preceding the southwest monsoon, the rainfall will be scanty, and the reverse if it is falling. On the other hand, if it is just beginning to rise during the month preceding the winter monsoon (November), the rains which fall in December and January will probably be above the average, and vice versa. These waves occur, reversed in phase, on the south side of the Equator, and indicate, as Mr. Eliot (the head of the Indian Weather Bureau) says, checks and accelerations in the seasonal mass transfer of air across the Equator between the Indian Ocean and Southern Asia.

Twelve such waves have occurred during the past twenty years, and their careful study seems destined to open out a new departure in meteorology by permitting seasonal forecasts to be projected on a rational basis.

Regarding the forecast last year, though no direct reference was made to the possibility of a famine producing drought, attention was drawn to the signs of a weak monsoon from the observations, particularly at the Seychelles.

Up to the present time the probability of a break in the middle of the rains or their early termination in any year are admitted to be difficult to determine with accuracy. The latter is, perhaps, one of the most important relations to be able to forecast, since the present disastrous scarcity is directly traceable to an unusual scorching in September, when the monsoon ought still to have been exercising its moist and sheltering influence.

At the existing rate of progress, however, there is little doubt that the possibility of predicting an early stoppage as well as a diminished strength in the monsoon will be shortly within the power of the Indian Meteorologist-in-Chief, and it is to be hoped that the successful example of the bold experiment of predicting weather conditions half a year ahead in India will stimulate European weather bureaux to advance beyond their present unsatisfactory position.—Knowledge.

EUCALYPTUS CALOPHYLLA.

A HEALTHY young tree of this handsome gum tree has lately flowered freely in the temperate house at Kew, says the Gardeners' Chronicle. It was planted out in a bed of peat at the south end of the house about three years ago, and it has grown with exceptional vigor, Eucalypti generally growing spindly and weak in this house. Eucalyptus calophylla is one of the most ornamental of the hundreds of species known. I have seen large examples of it in South Africa, where it is grown in gardens, and also as a street tree. It was also recently noted in Garden and Forest as one of the most beautiful of the Eucalypti grown in California, where it endures several degrees of frost. It forms a sturdy, leafy, pyramidal tree, and flowers when from 12 to 20 feet high, the flowers being borne in crowded clusters on the young branches, each flower consisting of a green woody cuplike calyx, and a brushlike cluster of white stamens 2 inches across. The leaves are ovate lanceolate, about 5 inches long, bright green, with a whitish margin, the midrib, petiole and bark of the young branches being bright red. The species was introduced to Kew by Allan Cunningham from King George's Sound, where it forms an immense tree. It flowered at Kew for the first time in 1843. The wood of this species is said to be of considerable value, being hard, close grained and finely veined.

EUCALYPTUS CALOPHYLLA.

FOUR cakes of manufactured ice averaging more than eight thousand pounds each were taken from the vats of an Orange, Tex., company. One weighed nine thousand pounds and measured 16 feet by 8 feet and was 14 inches thick.

THE CAMPHOR TREE.

THE increasing demand for camphor to be used for medicinal and technical purposes, as well as for the preservation of clothing, etc., has greatly raised the price of the article, for its production is limited. Camphor is procured in Japan, Formosa and, to a certain extent, in China; most of it grows in Japan and is shipped from Kobe to Europe and the United States. At present the amount produced is decreasing, for the trees have been ruthlessly cut down and no rational care taken for future needs. When young, the

BLOSSOMS OF THE CAMPHOR TREE.

trees grow very slowly and require careful attention, but later they grow faster and sometimes reach a great age, as is shown by the enormous size of their trunks, which have been known to measure 48 feet 6 inches in circumference, with a diameter of 14 feet 8 inches, and 115 feet in height. The age of such trees cannot be told with certainty, as they are apt to be hollow, but they are supposed to be from one to two thousand years old. Trees that are four or five hundred years old are not uncommon. As will be seen from the accompanying engraving, when these trees stand alone the branches begin near the ground, so that portion of the trunk that is free from branches is very short, but when the trees grow in the woods the trunk is sometimes nearly fifty feet tall. Dr. Grasmann, in the "Mittheilungen der deutschen Gesellschaft für Natur- und Völkerkunde Ostasiens in Tokio," writes as follows in regard to single trees that are found near temples:

"The camphor tree resembles the German linden in many respects; it is strong, but soft and yielding, not rough and gnarled like the oak, with which it could not be properly compared. The mighty crown of one of these trees, when seen from a distance, looks like a green hill in the landscape; it is seldom symmetrical, but usually very full, even when the tree is very old. These evergreens love a damp climate and grow best on a slight elevation with a southern and eastern exposure. They grow on the sides of mountains that slope gently to the sea, but are not found more than twenty-five miles from the sea nor higher than two thousand feet. In Japan they sometimes grow wild and sometimes are cultivated, and in the latter case are raised either from the seed or from small plants.

Woods consisting entirely of camphor trees are unusual. They generally grow with other trees.

"In Asia the wood of the camphor tree is used for various purposes. Formerly war vessels were built of it in Japan, but, of course, it is no longer used for such purposes, on account of its increased value, but furniture and chests for the preservation of clothing, etc., are made of it. In order to get the camphor the wood is cut up into chips and heated with water in a very primitive manner. The camphor is thus distilled and condensed in a cool receiver. The raw camphor obtained in this way is purified by Europeans in Kobe before it is shipped."

Science places the camphor tree in the Lauraceæ family, giving it the name of Cinnamomum camphora Nees et Eberm. It is closely related to the cinnamon tree and not quite so closely with the laurel, the only evergreen representative of the family in Europe. It is found along the coast of eastern Asia from 10° to 24° N. latitude, from Cochin China to the mouth of the Yangste-Kiang; also on the islands of Formosa, Hainan and Chusan; and it also grows in the southern part of Corea and of Japan. It has been planted on the Riviera in Europe, where it thrives well and grows fast, in the Southern States of North America, in California, in Buenos Aires, on the Canary Islands, on Mauritius, etc.—Illustrirte Zeitung.

THE CAMPHOR TREE.

GEM FIELDS OF THE WORLD.

GEORGE F. KUNZ, in the New York Sun.

LITTLE was known of the ruby mines of Burma until England finally conquered the Burmese kingdom in 1888. This was accomplished by two expensive wars, and concessions for working the mines were exacted from the king as indemnity. Such was the idea of their richness that, when the Burma Ruby Mines Company, Limited, was organized in London, the spectacle was witnessed of white-haired millionaires being clubbed away from a banker's office which they blocked in their eagerness to obtain a stock that was subscribed for three times over before the books were opened for the public, immediately selling for three times par. This stock, however, has not earned a dividend up to this day, and is quoted at less than 20 instead of 300. Last year the company's payment to the Indian government was reduced to encourage the enterprise, which has proved very unprofitable. The climate is the greatest enemy of the European. Of fifty English officers who visited the mines, forty-eight had the local fever; the other two had had it before.

The rubies, always associated with the ruby-red spinel, occur in a layer of sand and gravel in the valley bottoms, resulting from the breaking down of crystalline limestones, and are obtained by digging pits as deep as is practicable before they fill with water, and from open cuttings in the hillside; also from cavities and caves in the beds of granular limestone; rarely by quarrying into the rock. The limestone, the original matrix of the ruby, is identical with the rock in which opaque rubies and immense spinels are found in Orange County, New York.

In Siam, the gem producing district lies in the interior, not very far from Bangkok. It produces many small, but good, rubies, sapphires, etc., and is worked by various persons and companies holding concessions from the government. The gems are found in a layer of soft, yellowish sand, at a depth of from a few inches to twenty feet. The methods of working are of the most primitive Oriental kind.

In Macon County, N. C., in an alluvial deposit from the breaking down of crystalline rocks, some crystals of ruby have been found in flat, hexagonal tabular forms. A number of small gems have been cut from these, all of good color, and quite equal to the medium rubies from Burma.

The sapphire occurs associated with the ruby, in similar situations, and is also found where rubies have not been as yet. Ceylon furnishes many of the best, but they also occur, of fine quality, in Burma, Siam, and the Himalayas, and rarely in the Ural Mountains and the United States. In Ceylon, the ruby, sapphire, spinel, alexandrite, cat's eye, and other gems are all found as rolled pebbles in gravel, in or near old river beds in the government of Kandy.

Ratnapura, the city of rubies, at the foot of Adam's Peak, at Ceylon, an altitude of 6,000 feet, is a great mining center. Pits are sunk to the depth permitted by the pumping appliances in search of gem-bearing gravel, and when this bed is not reached within the limit of possible water clearance the pit is abandoned and trial made elsewhere. It seems as if, with the application of machinery adequate to keeping the pits clear of water, this constant abandonment of those sunk would no longer be necessary, and the profits known to have been made by native workers would be largely surpassed by the Europeans.

But the hopes entertained as to both Burma and Ceylon have been disappointed hitherto; nor does there appear any chance of future success, unless with some improved methods of machine working. One who has been active in this gem mining enterprise says:

"What we want is an honest machine, one that will not only obtain for us the gemiferous stuff, but would securely guard it from the pickers and stealers until it can be raised to the surface and treated under European supervision."

This is impossible down in the pits of Ceylon, as no European could long endure their heat. As a result of the work undertaken by European mechanical agency in Ceylon, the bazars of Colombo were fuller than had been ever known before of gems of various kinds; but few of these had passed through the hands of the companies working the mines.

Nearly all the fine sapphires of the past fifteen years are from a very remarkable discovery made in 1882, in the Zenskar range of the Himalayas, in northwestern Kashmir, near the line of perpetual snow. A landslide removed an abundance of sapphires, which at first were used as gun flint by the natives. One writer speaks of having seen about a hundredweight of them in the possession of a single native. Traders, however, soon carried them to commercial centers, where their value became known. The Maharajah of Cashmere promptly sent a regiment of Sepoys to seize upon the mines and to harry the natives who were suspected of having stones in their possession or any knowledge of new localities where the gem could be found.

In our own country, corundum occurs at various places along the eastern flank of the Appalachian Mountains. At Franklin, Macon County, N. C., Col. C. W. Jenks first mined gem sapphires associated with corundum, and a number of blue, purple and green stones, as well as rubies, up to one carat, and of fine color, were taken out of the crystalline rocks of this region. On the Missouri River, on certain bars near Helena, and elsewhere in Montana, sapphires occur in an auriferous glacial gravel, resting on a slaty bedrock, where they have been found occasionally with mastodon bones as a by-product in gold mining since 1864.

A careful survey of one of the best of these, Eldorado Bar, led to the estimate that it would yield some 2,000 ounces of sapphires to the acre; but only a part of these may be of gem quality. The stones found embrace a great variety of light shades of red, yellow, blue and green. The latter color is quite pronounced, being rather a blue green than an emerald green. Nearly all of them, when finely cut, have a marvelous metallic luster, very beautiful, and strikingly peculiar

to these from this locality. Much money has been spent here in work, but no true red rubies or true blue sapphires have been found; the so-called rubies found here, if of any deep color, are generally pyrope garnets.

The finest turquoises, and richest in color, have been found, for centuries, in small veins in a clay slate near Niskapoor, near Meshed, Persia; but these mines, long so prolific, have been rudely worked, and are now almost exhausted. Many turquoises reach the market from Egypt; they are really obtained from Mount Sinai. This variety, although generally dark blue when found, often changes in a short time to a milky green. Very lately, also, turquoises have been announced in New South Wales, Australia, but the yield thus far has been trifling and of a very inferior quality. Santa Fé, New Mexico, is the principal source of supply, and so are the Buno Mountains, Grant County; the rocks here are yellow and gray quartzite sandstone with porphyry dikes; the sandstones are, probably, of carboniferous age, but so uplifted and metamorphosed that their sedimentary character is obscured.

Nearly every mine so far discovered was worked by the natives before the advent of the Spaniards. The Spaniards seized upon the turquoise mines at Los Cerillos when they conquered New Mexico, and forced great numbers of captive Indians to work them, but in 1680 a large part of the mountain fell in, crushing a number of miners. This accident was the immediate cause of an uprising of the Pueblos, which led to the expulsion of the Spaniards. The Pueblo Indians procured the turquoise by cracking the rock from the sides of the mine by throwing water on the walls after they had been heated by fires built against them. The process generally injured the color. But since 1890 improved methods have been successfully used. Recent explorations have disclosed old workings in all the mines of New Mexico and Arizona, fragments of pottery, stone hammers, and similar objects are found on the ground and are discovered within the long-hidden chambers, as also in the similar case of the Arabian turquoise mines near Sinai.

Companies are now working mines near Los Cerillos and the Buno Mountains, New Mexico, and elsewhere in that region. Much of the product is pale in color, but a great quantity of fine turquoise of robin's egg blue, equal to the finest Persian stones, is obtained, and a single piece sold for $4,000 is reported. Many of these gems have gone to Europe, where their excellence is acknowledged, and the total American sales from 1890 to the beginning of 1894 were not less than $500,000. This has proved the most profitable gem mining in the United States.

The most productive emerald mines, affording the finest gems, are near Muzo, an Andean village, in the State of Boyaca, United States of Colombia, about eighty miles northwest of Bogota. These mines lie in a deep round valley, and have been worked for many centuries before the advent of the Spaniards. They are now the property of the government, which rents them to a company. Emeralds from these mines the Spaniards brought from Peru and took to Spain, where they were sold within a short time to Farther India. The mine itself is an excavation about six hundred feet wide, at the base of an abrupt cliff of bituminous limestone. This company employs five or six overseers, and 300 to 400 native workmen, who are lodged and fed on the premises, and get twenty to forty cents a day. The work is done simply by tearing off with crowbars fragments of the rock from the side of the mine, which is cut into narrow terraces, like a gigantic staircase, and throwing them into a trough at the bottom. When a certain quantity has been tumbled down, a heavy rush of water from a reservoir is sent through, breaking up and carrying away all the light rock and disengaging the emerald crystals. These, being heavy, sink to the bottom of the sluices and are caught by the riffler. This is simply the operation of sluices, well known to placer miners for gold. The emeralds occur in cavities and among the loose black powder which fills many of the veins. The sluice boxes are watched very carefully, but, as elsewhere, a large proportion of the stones are stolen and surreptitiously sold by the workmen. All the emeralds saved are at once sent to Paris to be cut. The product is worth about $100,000 a year.

The most recent discovery of emeralds is at the Emmaville mines in the northern part of New South Wales. The emeralds occur in a granite rock, and are generally crystallized out as implanted crystals. Although 40,000 carats of these stones have been found, they are generally very pale in color, and no really fine gems have been obtained.

Magnificent emeralds have come from the rich and varied gem deposits on the Siberian side of the Ural Mountains. For nearly two centuries the Urals have been noted for their remarkable productions of beryl, emerald, amethyst, topaz, both blue and sherry color, tourmaline, alexandrite, phenacite, and other minerals and gems that for beauty and quantity have given this region a foremost place in the mineralogical collections of the world. The mines are mainly open excavations. They are worked only by peasants of the Ural Mountains when they are not busy in the fields, never by proper machinery, yet they are a source of revenue to the Russian crown. The emerald mines of Takowaja, near Ekatherinburg, were leased for many years to a company at an annual rental of 60,000 rubles, but have not been worked since 1850, when the company could not afford to pay the rental, and until some one pays it, emeralds will not be mined in Russia again. Many fine gems were found here, as well as the alexandrite and phenacite. The magnificent beryls of Russia were found about sixty miles north of here and in Siberia.

Emerald mining in the United States is of recent development. At Stony Point, in Alexander County, N. C., in 1880, beautiful light colored specimens were found, but not in profitable quantities or of good quality. They occur in a red gravelly clay and in the gneissoid rock of the Blue Ridge, the former a decomposition of the latter. As crystals they are magnificent, but they have little gem value. All those obtained by the Emerald and Hiddenite Mining Company in a dozen years of working at these mines have not exceeded $15,000 in value. Some fifty miles west of Stony Point, in Mitchell County, a new locality was discovered in 1894, but none of the material afforded gems.

Fine beryls occur at Stoneham, Me., and on Mount Antero, Col., at an altitude of 13,000 feet, and at a mica mine near New Milford, Conn., where $15,000 worth were found between 1886 and 1889.

It is in granitic rocks that the finest yellow topaz is found, at Minas Geraes, Brazil, as well as the blue, green and white topazes in Perm in the Ural, in Siberia, Japan, Madagascar, New Zealand, and in 1889 at Bald Mountain, near Chatham, N. H., in Colorado and Texas, and in igneous rocks in Colorado, Mexico, Australia, Straits Settlement, etc.

Garnet is a widely distributed gem occurring in many varieties in almost all mountain ranges composed of crystalline rocks, and under very diverse geological conditions. From the gold washings at Sysserk, in the Ural Mountains, come green garnets of high value, erroneously called olivine, while the Pegu mines in the Rangoon district of British Burma and Jeypur, India, furnish the purple almandines of great beauty in unlimited quantities. Ceylon produces the honey-red essonite, which closely resembles the honey-red spessartite of Amelia Court House, Va., that has recently been found as a by-product in mining for mica. Wine-colored garnets of value also come from the Tyrol, while at several American localities, especially along the Columbia River, large quantities of purple almandite have been found in the form of rolling pebbles. The finest red garnet, however, is the blood-red pyrope, found in Bohemia, South America and the United States. In Bohemia nearly all the garnets are in an alluvium equivalent to our glacial deposits, and associated with a variety of fossils, also with sapphire, zircon, etc. Such quantities of minute garnets remain in the sands that result from the operation of washing the soil and gravel that the sands are kept and sold for garden paths.

Orders now in with different car works will aggregate about 50,000 cars, and orders in sight at this time with locomotive works will foot up to about 300 engines, says Locomotive Engineering. Car works are running with only about one-half of their usual complement of men. Locomotive works, it is said, are employing a somewhat higher number at present—about 60 per cent. of the usual force.

AN IVORY SALE AT ANTWERP.

THE last sale of African ivory at Antwerp, that of November 3, brought together 123,000 pounds, and thus took the second rank in importance among the four sales of last year, and, from one of the accompanying engravings, it may be seen that the quarterly sales of this product at Antwerp are as important from the number of the tusks as from their dimensions, which are often phenomenal. Thus, among the tusks exposed for sale, there was one pair that weighed 350 pounds. Before going any further, let us have a word to say as to the commercial qualities that the tusks should possess. The ones most in demand are those whose diameter is wide enough to permit of obtaining billiard balls from the greater part of the tusk; that is to say, those that are the straightest.

Each tusk comprises three distinct parts: the epidermis, which the manufacturer must first remove; the heart or center, which may, if it is too elongated and too thick, cause a sensible loss to the purchaser; and, finally, the hollow, which forms the bell, as it were, of the huge horn that an elephant's tusk resembles. The hollower the tusk, the less it is worth. As for the grain, the closer and finer that is, the more the ivory is esteemed. This depends upon the region whence the ivory comes. Thus, for example, the ivory of the upper Congo is regarded as having too coarse a grain. Slits or cracks are the principal defects of the tusks, not to speak of what are technically called "fevas," which form in the interior of the tusk a parasitic osseous substance, which is the cause of a depreciation that is sometimes absolute.

NATIVES CARRYING ELEPHANTS' TUSKS TO CONGO.

Among the tusks in demand (which may weigh from 40 to 150 pounds), those that are the most esteemed are the ones called "bangles," and which must be perfectly sound, smooth and round. These are used for turning the large rings or bracelets that the natives wear upon the arms and ankles. The tusks that exhibit rings in the form of excrescences and those derived from domestic elephants and bearing the marks of ropes, etc., are rejected.

The ivory market of Antwerp, organized scarcely five years ago, has become the largest one in the world—

larger than the two other great markets, that of London and that of Liverpool. In London, in 1895, there were offered 587,400 pounds and at Antwerp 598,400. During the same period, Liverpool handled but 125,400 pounds. Of the 598,400 pounds sold at Antwerp, 455,000 came from the independent state of Congo.

In themselves, the sales of ivory offer no peculiarity, especially at Antwerp, where only certain local brokers are allowed to take part in them. A few days previous to the sale, the tusks, classified by numbered lots and catalogued, are exposed in a spacious hall to the inspection of experts, who submit them to a close examination. This scene is represented in one of our engravings.

Whence comes all this ivory? From Belgian Congo, in great part, as we have just said; but the independent state is itself a country of transit for large quantities and for the following reasons: Lupton Bey and Emin Pasha collected together in the Soudan enormous quantities of ivory, which fell into the hands of the Mahdists and became scattered through the country. Much of this was drained off by the state of Congo, which has become the great outlet of ivory for Europe.

INTERIOR OF THE IVORY MARKET AT ANTWERP.

What is the consumption of ivory? The following are some curious figures upon this subject: From 1889 to 1893, the average consumption of this product was 402,600 pounds in England, 255,200 in America, 198,000 in France, 248,600 in Germany, 266,200 in the Indies, 28,600 in China, and 13,200 in other countries; say a mean annual consumption of 1,412,400 pounds. If it be reflected that ivory is worth, on an average, $1.70 a pound at Antwerp, it will be seen how great is its commercial role.

What is the future of this traffic, which has caused streams of gold and blood to flow? Such future is threatened, since the elephant is tending to disappear, a victim of the unrestrained pursuit of which he is the object. So the state of Congo has taken in the situation and elephant hunting has just been made the subject of a decree, published in the official bulletin of the state, whereby it is forbidden to hunt the animal in close seasons fixed by the heads of the European districts. Moreover, the native chiefs recognized by the state alone have the right to hunt the elephant or to cause it to be hunted, and, further, they must pay to the European heads of districts a tax that is equivalent to half of the ivory collected by them or by those of their people that have a permit. There is also a question of organizing elephant farms in Congo, just as the English have established ostrich farms in Egypt. In the meanwhile it is evident that the collection of ivory is depriving the state of Congo of an agent of transportation of the first rank. But we would want ivory, even if there were no more of it in the world!—L'Illustration.

INSURANCE OF INFANTS' LIVES.

EARLY in August, says the Lancet, a medical practitioner in Eastbourne was called to attend an infant aged seven months. He found what appeared to be a diminutive living, or rather dying, skeleton, filthy, covered with vermin, and quite beyond the hope of recovery by medical treatment. Other witnesses have since added to the history of this case detailed explanations of deliberate neglect for which the parents had even been sent to prison. Nevertheless, an insurance agent regularly received a weekly dole of twopence, which appears as the sole suggestion of parental interest, and which would one day, it was expected, reward that interest with a solatium of £5. We have here but one more example illustrating the connection which, whether natural or not, does certainly exist between this system of infant life insurance among the poor and infant mortality under the most cruel conditions. The question how this connection can be most effectually severed has not yet found a practical answer. Infant insurance is not, after all, a domestic necessity. If it be adopted as a matter of convenience, no objection to it can be raised, provided that effectual means be used to prevent its criminal abuse; but this condition is essential. The system in force in mutual benefit societies is in some degree guarded by the intercourse existing among their members and by the fact that insurances as a rule are not on an extravagant scale, and it has come to be regarded as in some sort a model. It by no means follows that even this arrangement is incapable of improvement, and it is certainly open to question whether the present system of money payment on the death of an insured child is that best calculated to effect the professed purpose of the insurance. In the case of sickness a different plan is followed. The small weekly contribution does not bring in a return in money to defray the expense of treatment, but it guarantees the professional aid of a practitioner. Why should not the cost of burial be defrayed on the same principle? It would probably cost less to employ the services of an undertaker than to disburse a sum which must often be in excess of the actual requirements of burial, and we cannot imagine any method which would more effectually remove from poor and unscrupulous parents the temptation to make away with children for the sake of a burial policy.

A POSSIBLE CAUSE OF CHANGE ON THE MOON'S SURFACE.

By CHARLES DAVISON, Sc.D., F.G.S., in Knowledge.

IN spite of the fruitless search of many years, astronomers have not yet apparently given up hope of discovering changes on the moon's surface. And the hope does not seem to be altogether without foundation. In the great changes of temperature which take place on the moon, changes which are untempered by any atmosphere such as we possess, there resides a cause capable perhaps of producing effects that may in time become perceptible to our telescopes.

The suggestion that such may be the case is due, I believe, to Messrs. Nasmyth and Carpenter. During the long lunar day, they remark, the surface attains a temperature of about 500° F., and during the equally long lunar night one of about —250° F. "Such a severe range of heat can hardly be without effect upon some of the component materials of the lunar surface. If there be any such materials as the vitreous lavas that are found about our volcanoes—such as obsidian, for instance—they are doubtless cracked and splintered by these extreme transitions of temperature; and this comparatively rapid succession of changes continued through long ages would, we may suppose, result in a disintegration of some parts of the surface, and at length somewhat modify the selenographic contour." On the other hand, "it is possible," they add, that "the surface matter is mainly composed of more crystalline and porous lavas, and these might withstand the fierce extremes like the 'fire brick' of mundane manufacture, to which in molecular structure they may be considered comparable. Lavas as a rule are (upon the earth) of this unvitreous nature, and if they are of like constitution on the moon, there will be little reason to suspect changes from the cause we are considering." They think it conceivable, however, that "the alleged changes in the crater Linné may have been caused by a filling of the crater by some such crumbling action as we are here contemplating."*

In making this suggestion, Nasmyth and Carpenter are appealing to no imaginary agency. Several instances might be given of the spintering of terrestrial rocks by more or less sudden cooling. It will be sufficient to mention one case, observed by Livingstone in the valley of the Gova, a river flowing into Lake Nyassa. "Several of the mountain sides in this country," he says, "are remarkably steep, and the loose blocks on them sharp and angular, without a trace of weathering. For a time we considered the angularity of the loose fragments as evidence that the continent was of comparatively recent formation, but we afterward found the operation actually going on by which the bowlders are split into these sharp fragments. The torrid sun heats the rocks during the day to such an extent that one is at times startled on sitting down on them after dusk to find them quite too hot for the flesh, protected by only thin trousers, to bear. The thermometer placed on them rises to 137° in the sun. These heated surfaces, cooling from without by the evening air, contract more externally than within, and the unyielding interior forces off the outer parts to a distance of one or two feet. Let any one in a rocky place observe the fragments that have been thus shot off, and he will find in the vicinity pieces from a few ounces to one or two hundred pounds in weight, which exactly fit the new surface of the original block; and he may hear in the evenings among the hills, where sound travels readily, the ringing echo of the report, which the natives ascribe to Mchesi or evil spirits, and the more enlightened to these natural causes."†

If changes of temperature can produce such effects on the earth, they must act still more powerfully on the moon. There, especially on the mountain sides, large areas are suddenly exposed to, or withdrawn from, the action of the sun's rays. Moreover, the range of temperature, as we have seen, is enormously greater. Thus, if the rocks which compose the lunar mountains resemble even approximately those which are found upon the earth, there must evidently be much fracturing and splintering; level or inclined surfaces must in places be covered with loose fragments of rock, while against the steeper hillsides slopes of loose rocks, or "screes," must be piled up.

It appears to me that these screes, if they exist and are perceptible, are the regions where signs of change should be especially looked for. As fresh fragments fall down from the crags above, the slopes of the screes increase until they attain, or nearly attain, their maximum inclination. The surface blocks are then in a highly unstable condition, and every newly fallen rock showers down numbers of others all around it before it finally comes to rest.

Thus, if screes are found at all upon the moon, they will continually increase in size until they mask they parent cliff. So far as we know, there is little to check their rate of growth, except that growth itself, which gradually lessens the area from which new blocks are to be derived. The blocks themselves may splinter still further until the spaces between them are filled up with small fragments and dust, and thus may perhaps retard their movement; but there can be no veg-

* "The Moon: considered as a Planet, a World, and a Satellite," 1885, pp. 172-174.

† "The Zambesi and its Tributaries," pp. 492, 493.

etation to find a root in this soil and so bind the surface stones together.

While changes of temperature furnish the materials of screes, and gravity rearranges them, these two agencies in concert are capable of producing a further movement of the blocks, to which it is my principal object in this paper to draw attention.

A little more than forty years ago, part of the lead on the roof of Bristol Cathedral was found to have crept downward, the total descent being about a foot and a half in two years. Soon afterward the now well known explanation of the movement was given by Canon Moseley. When the lead is heated it expands, but it is easier to move down the slope than up it; so that, while some of the lead at the top of the sheet moves upward, a far larger part moves down. When the lead is cool it contracts; part near the lower edge moves up the slope, but a far larger upper portion moves downward. Thus, on the whole, with every change of temperature to and fro, the whole sheet of lead makes a short creep down the slope.

In this case, since the sheet lead is thin, the movement is principally due to the fact that the lead and wooden surface on which it rests have unequal coefficients of expansion. If they had been of the same material, the creep would have been almost imperceptible. When, however, one stone rests upon another of the same kind, the two are unequally heated on account of the small conductivity of rock, and the ultimate result is the same.

A few years ago I made some experiments on the creeping of stones arising from changes of temperature.* In the first, one brick was placed on another inclined to the horizon at an angle of twenty degrees. On the upper edge of the upper brick, and on another independent brick support, a level was placed with the bubble in the center of the tube. The level was read frequently, and it was found that while the upper end rose slightly during the day, it descended by a greater amount during the night, so that at the same time each day it stood at a lower level. This experiment showed that the stone did creep in the manner supposed by Moseley, though it gave no idea of the extent of the movement, as the angular value of the scale divisions of the level was undetermined.

The object of a second experiment was to ascertain how far a stone would creep in a year under given conditions. I had two slabs of York stone cut, each three feet long, five inches wide, and two inches thick. One face and one side of each stone were smoothed, and the stones were placed with their smoothed surfaces in contact, and inclined at an angle of seventeen degrees to the horizon. The smoothed sides of the two stones were continuous, and three fine scratches were made on them, in the middle and at each end, so as to be at starting in the same straight lines. At the end of a week the displacement of the upper stone, though exceedingly slight, was quite perceptible, and it continued so throughout the year, the total creep in this interval being thirteen and one-sixth millimeters, or a little over half an inch.

So small a movement may be considered hardly worth taking into account. But it must be remembered that it affects every stone free to move and resting on an inclined surface. Moreover, the creep is proportional to the length of the stone and to the range of temperature to which it is subjected, and the length of the lunar compared with that of the terrestrial night is probably more than counterbalanced by the magnitude of this range.

If changes in the manner here described do take place upon the moon, it is evident that they must be exceedingly gradual. Years must elapse before they become perceptible to us; but as the changes would take place always in one direction, it seems not impossible that a careful scrutiny of a few selected districts would in time reveal their existence.

The monks of the middle ages were usually sagacious enough to select fertile and sheltered locations for establishing their cloisters, and they surrounded them with rich fields and gardens, says Garden and Forest. At Interlaken, Switzerland, on the deep alluvial soil deposited by the rivers which came down from the great Bernese Oberland, a monastery and nunnery were founded in 1130. The monks planted a grove of walnuts, Juglans regia, about their buildings and a long avenue connecting the cloisters with the neighboring village of Aarmuhle. They had learned from the east and south, no doubt, the value of the rich, fruity oil yielded by the walnuts, and to this day it is pressed in quantities here and used as a substitute for olive oil. The walnut trees still survive, hoary with age, picturesque and venerable. They now line the fashionable promenade, Hoheweg, where the whole world throngs to pay homage to the Jungfrau, crowned with her eternal snows. Throughout the country round about here walnut trees are very common, and they are probably seedlings from nuts which have been carried away by squirrels from the parent trees. Today, within the walls of the old cloister, the present Kreis Forester of Interlaken has established a little "plant school," where all sorts of seedlings are grown, to be used in the work of protecting the flanks of the mountains against torrents from melted snow. Thus the monks builded better than they knew, and, in a certain sense, the modern forester here is their lineal successor.

A new composition brakeshoe for railway purposes that has shown some very excellent results during recent tests is being introduced in America. This shoe consists of a cast iron shell filled with composition material. The composition consists of cast iron borings, carbon in the form of charcoal, asbestos, resin, black lead and linseed oil. These materials are put in the shells under heavy pressure. The shoes are then baked in a furnace at a high temperature. With this shoe, says the Railroad Gazette, is used a brakehead and connections, which provide for a steel spring behind the shoes, so that the braking pressure is transmitted by means of the spring to the shoe and forms a cushion. This spring takes up the vibration and chatter and equalizes the pressure on the shoe, hence increasing its life.

* "Note on the Movement of Scree Material," Quart. Jour. Geol. Soc., 1898, pp. 232-237, 825, 826.

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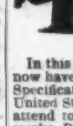

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